THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

DECEMBER · 1915 ·

ANNUAL MEETING, NEW YORK CITY, DECEMBER 7-10

SEVEN THOUSAND

THE membership of the Society will approach the seven thousand mark before the end of the year; this means that the Society has doubled its membership in the last five years. The growth has been made up of the leading engineers of all parts of the world.

The healthy condition of the Society is due to the policy of promoting the welfare of the individual engineer through the development of high ideals in the profession and its activities in all matters of public interest—and this without overlooking the human element.

One of the greatest benefits to the Society, and in turn to its individual members, which goes hand in hand with this increased membership, has been the founding of Sections. Obviously, it is necessary that there be a certain number of members in any locality before a Section can be established, and as rapidly as the membership develops in any district organized meetings will be fostered.

The Committee on Sections aim to secure during the coming year meetings of the Society in as many places as possible. The initiative must come from the members in any locality, but as soon as there is interest the Committee and the Council will immediately assist by appropriation and cooperation.

The Committee on Increase of Membership is paving the way for still further "Section development" by encouraging increased membership, especially in outlying districts.

Total Membership of the Society, November 19, 1915 . . . 6600
New Members since January 1, 1915 581

Invitations to the Annual Meeting will be mailed to engineers upon the request of members

CHANGES OF ADDRESS

Members who have changed their addresses during the past year and who have not notified the Society are requested to fill out the blank below as indicated and return it to the Society. These corrections are for use in the Year Book for 1916, and should be received by December 15 to insure their appearance.

(Cut off along this line)

The American Society of Mechanical Engineers

29 West 39th Street, New York

ADDRESS BLANK

(Fill in every space below. Write distinctly. Typewriting preferred)

Underline the Mail Address

Name...

Title or Position...

Name of Firm..

Business Address..

....

Home Address..

....

....

A new Year Book is about to go to press. Please return this sheet not later than December 15, 1915

THE JOURNAL OF
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Volume 37 | DECEMBER 1915 | Number 12

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PUBLISHED MONTHLY BY

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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THIRTY-SIXTH ANNUAL MEETING

New York City, December 7 to 10, 1915

LIST OF TOPICS TO BE DISCUSSED

Abrasive Wheels
Accident Compensation
Automatic Machine Tools
By-Product Gas Producers
Chimney Proportions
Circulation in Boilers
Electric Elevators
Electrically-driven Tools
Engineer and Fire Insurance
Engineering and the Executive
Fire Tube Boilers
Foundations
Heating Textile Mills
Higher Steam Pressures
High Vacuum Condensers
Hydraulic Power Plants
Large Electric Plants
Locomotive Axles
Oil Engine Vaporizers
Orifice Gas Meters
Passenger Car Trucks
Prevention of Corrosion
Private vs. Purchased Power
Protection of Workers
Safety Methods
Safety Principles
Steam Pipe Coverings
Strength of Porcelain
Strength of Stoneware
Turbines vs. Engines

LIST OF AUTHORS OF PAPERS

Dan Adams, Mem. Am. Soc. M. E.
Allen H. Babcock
Paul A. Bancel, Jun. Am. Soc. M. E.
J. S. Barstow
James E. Boyd
L. C. Brooks, Jun. Am. Soc. M. E.
L. D. Burlingame, Mem. Am. Soc. M. E.
Robert Cramer, Mem. Am. Soc. M. E.
F. W. Dean, Mem. Am. Soc. M. E.
Albert G. Duncan, Mem. Am. Soc. M. E.
Geo. H. Gibson, Mem. Am. Soc. M. E.
Hollis Godfrey, Mem. Am. Soc. M. E.
Ernest O. Hickstein, Jun. Am. Soc. M. E.
C. F. Hirshfeld, Jun. Am. Soc. M. E.
Louis Illmer, Mem. Am. Soc. M. E.
David Lindquist
Arthur H. Lymn
L. B. McMillan, Jun. Am. Soc. M. E.
Charles T. Main, Mem. Am. Soc. M. E.
Anatole Mallet, Hon-Mem. Am. Soc. M. E.
A. L. Menzin, Assoc-Mem. Am. Soc. M. E.
Mark A. Replogle, Mem. Am. Soc. M. E.
Frank W. Reynolds, Mem. Am. Soc. M. E.
Roy V. Wright, Mem. Am. Soc. M. E.

For program of the meeting see page VI.

MEETINGS OF LOCAL SECTIONS

December 1, *St. Louis, Mo.* The President of the American Society of Engineering Contractors will address this Section.

December 1, *Buffalo, N. Y.* Subject: Internal Conveyors, by Fay B. Williams, Engineer of the Lamson Company.

December 15, *Buffalo, N. Y.* Subject: Engineers in Politics, by C. E. Drayer, Secretary of the Cleveland Engineering Society.

December 16, *Cincinnati, O.* F. L. Raschig will discuss the paper on Engineering Features of the Panama Pacific International Exposition by Guy L. Bayley, Mem. Am. Soc. M. E., using slides which Mr. Bayley made at the Engineering Congress at San Francisco.

December 16, *Minnesota.* Subject: Engineering Education in the British Isles, by John J. Flather. Dinner will be served at 6:30.

December 18, *St. Louis, Mo.* The Local Section of St. Louis will hold a dinner for the introduction of new members.

January 5, *Buffalo, N. Y.* Subject: The History of Iron, by Dr. J. A. Mathews, Mem. Am. Soc. M. E., of the Halcomb Steel Company.

April 11-14, *New Orleans, La.* Spring Meeting of The American Society of Mechanical Engineers.

THE JOURNAL OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Volume 37 December 1915 Number 12

THE ANNUAL MEETING

THE thirty-sixth Annual Meeting will be held in the Engineering Societies building, 29 West 39th Street, New York, beginning on Tuesday, December 7, and ending on Friday, December 10. The attendance at annual meetings has been increasing steadily and last year's was the largest in the history of the Society. It is hoped that all members who find it possible to come to New York at the time of the meeting will do so, as this affords the greatest opportunity of the year for extending one's acquaintanceship. The Committee on Meetings has provided a program so varied that some part of it at least cannot fail to interest every member. The details of the program follow on another page, where the various professional papers are listed. Copies of these papers will be ready in pamphlet form in advance of the meeting, and any of them will be sent, free of charge, to any member asking for them previous to the time of the meeting.

Headquarters will be open for registration at 2 p.m. on Tuesday, December 7. In the evening the President, Dr. John A. Brashear, will give the annual address, on Science in its Relation to Engineering, followed by a reception to the President, Present-elect, ladies, members and guests. During his term as president Dr. Brashear has been very active among the membership. He not only has traversed the continent twice, but has made many other extended trips for the purpose of meeting members in different parts of the country. His lectures have delighted scores of audiences, and one of the anticipations of the present meeting is the pleasure of greeting and hearing Dr. Brashear at Tuesday evening's opening session.

ENTERTAINMENT FEATURES

On Wednesday afternoon, December 8, a reception and tea will be given in the rooms of the Society to the visiting ladies, members and guests. This will be under the auspices of the Ladies Committee and is one of the delightful and important social features of the Annual Meeting. It is usual to close the afternoon with dancing. All are cordially invited to attend.

Special attention is called to the Smoker on Wednesday evening, which is to be held at the Society headquarters. This is distinctly a members' reunion, having for its chief function the opportunity to extend one's acquaintanceship and to secure to the fullest extent the benefits which come from time spent together in an assemblage of engineers from all sections of the country. No program is to be announced in advance, but the New York Committee gives every assurance of a good time. The usual Wednesday evening lecture of the Annual Meeting will this year be omitted.

The dinner and dance on Thursday evening will be held in the Grand Ball Room of the Hotel Astor. An attendance of over 400 is expected and the preparations for this event, which have been completed by the local committee, assure an event fully equal to the reunions of past years, which have been so important and successful a feature of the program. In view of the fact that the members in previous years have been very late in arranging for attendance at the Thursday evening reunion, the Committee has this year provided for a special price of $5 per person to all who purchase tickets before 6 P.M. on Wednesday, December 8. After this time, the price of the tickets for the dinner and dance will be $6 per person. Early notification with regard to purchase of tickets should be made at headquarters.

EXCURSIONS

The plan this year will be to have a few excursions of exceptional interest rather than a multiplicity of less important trips. Visits are contemplated to the power and elevator plants of the Municipal and Woolworth buildings; to the 74th Street station of the Interborough Rapid Transit Company, where turbines of 40,000 h.p. are now running; and to the Brooklyn Navy Yard, where the battleship Brooklyn, designed to be the most powerful armorclad afloat, is under construction. A trip is also planned to one of New York's leading moving picture studios and to an aeronautical plant in the vicinity which is of interest.

PROGRAM OF THE ANNUAL MEETING

Tuesday Afternoon, December 7

Conference of Local Sections, 12:30 p.m. All Council members and official delegates of the Society's fourteen sections will meet to discuss ways and means for making the local sections of the utmost benefit to the membership. Other conferences of local sections will be held at intervals during the convention.

Registration Bureau opens, 2 p.m.

Council Meeting, 2 p.m.

Tuesday Evening

Opening Session: Address by Dr. John A. Brashear, President of the Society, on Science in its Relation to Engineering.

Reception by the Society to the President, President-elect, ladies, members and guests.

Wednesday Morning, December 8

BUSINESS MEETING

Reports of the Council and Standing Committees. Constitutional Amendments. Report of Committee on Standardization of Special Threads for Fixtures and Fittings and announcement of Report of Power Test Committee. New Business.

Immediately following the business meeting, the Society will honor the memory of the late Dr. Frederick W. Taylor, Past-President. The proceedings will consist of a report by a special committee appointed by the President to represent the Society at the Taylor Memorial Meeting held in Philadelphia on October 22 under the auspices of the Society to Promote the Science of Management.

PROFESSIONAL SESSION

Papers to be presented by title only

GAS PRODUCERS WITH BY-PRODUCT RECOVERY, Arthur H. Lymn

THE APPLICATION OF ENGINEERING METHODS TO THE PROBLEMS OF THE EXECUTIVE, DIRECTOR AND TRUSTEE, Hollis Godfrey, Mem. Am. Soc. M. E.

MODERN ELECTRIC ELEVATOR AND ELEVATOR PROBLEMS, David Lindquist

These three foregoing papers contributed by the New York local committee

TURBINES VS. ENGINES IN UNITS OF SMALL CAPACITIES, J. S. Barstow

Contributed by the Philadelphia local committee

THE CONNORS CREEK PLANT OF THE DETROIT EDISON COMPANY, C. F. Hirshfeld, Jun. Am. Soc. M. E.

Contributed by the Buffalo local committee

PROPORTIONING CHIMNEYS ON A GAS BASIS, A. L. Menzin, Assoc. Mem. Am. Soc. M. E.

The foregoing papers which are to be presented by title will be distributed at the meeting in pamphlet form, and written discussion upon them solicited for publication in The Journal. There will be no opportunity for oral discussion of these papers.

STEAM POWER

Papers to be presented by abstract

DESIGN OF FIRE TUBE BOILERS AND STEAM DRUMS, F. W. Dean, Mem. Am. Soc. M. E.

HIGHER STEAM PRESSURES, Robert Cramer, Mem. Am. Soc. M. E.

A NOVEL METHOD OF HANDLING BOILERS TO PREVENT CORROSION AND SCALE, Allen H. Babcock

This paper in preliminary form was presented before the San Francisco local section, December, 1914

Wednesday Afternoon

SIMULTANEOUS SESSIONS

RAILROAD

Papers contributed by the Sub-Committee on Railroads

OPERATION OF PARALLEL AND RADIAL AXLES OF A LOCOMOTIVE BY A SINGLE SET OF CYLINDERS, Anatole Mallet, Hon. Mem. Am. Soc. M. E.

FOUR-WHEEL TRUCKS FOR PASSENGER CARS, Roy V. Wright, Mem. Am. Soc. M. E.

TEXTILE

Papers contributed by the Sub-Committee on Textiles

HEATING BY FORCED CIRCULATION OF HOT WATER IN TEXTILE MILLS, Albert G. Duncan, Mem. Am. Soc. M. E.

RELATIVE VALUE OF PRIVATE AND PURCHASED ELECTRIC POWER FOR TEXTILE MILLS, Frank W. Reynolds, Mem. Am. Soc. M. E., and Dan Adams, Mem. Am. Soc. M. E.

MACHINE SHOP

Papers contributed by the Sub-Committee on Machine Shop Practice

AUTOMATIC MECHANICAL CONTROL OF LATHES AND SCREW MACHINES, L. D. Burlingame, Mem. Am. Soc. M. E.

ELECTRIC OPERATION AND AUTOMATIC ELECTRIC CONTROL FOR MACHINE TOOLS, L. C. Brooks, Jun. Am. Soc. M. E.

REPORT ON CODE FOR ABRASIVE WHEELS.

During the afternoon a reception and tea will be given in the rooms of the Society to the visiting ladies, members and guests under the auspices of the Ladies' Committee. This will be one of the important social features of the Annual Meeting and all are cordially invited to attend.

Conference of Student Branches.

Wednesday Evening

SMOKER

A departure will be made from the usual Wednesday evening lecture, by holding a Smoker in the rooms of the Society. This will be a get-together, get-acquainted meeting, in charge of the New York local committee, to which every member is invited for a social evening and a good time.

Thursday Morning, December 9

SIMULTANEOUS SESSIONS

POWER PLANT

THE HEAT INSULATING PROPERTIES OF COMMERCIAL STEAM PIPE COVERINGS, L. B. McMillan, Jun. Am. Soc. M. E.

PERFORMANCE AND DESIGN OF HIGH VACUUM SURFACE CONDENSERS, Geo. H. Gibson, Mem. Am. Soc. M. E., and Paul A. Bancel, Jun. Am. Soc. M. E.

CIRCULATION IN HORIZONTAL WATER TUBE BOILERS, Paul A. Bancel, Jun. Am. Soc. M. E.

UNIQUE HYDRAULIC POWER PLANT AT THE HENRY FORD FARMS, Mark A. Replogle, Mem. Am. Soc. M. E.

MISCELLANEOUS

THE FLOW OF AIR THROUGH THIN-PLATE ORIFICES, Ernest O. Hickstein, Jun. Am. Soc. M. E.

This paper is the Junior Prize paper for 1915, and bears the further distinction of being the first paper to receive a prize from The American Society of Mechanical Engineers. A fund for Junior and Student prizes was recently established by a member of the Society.

ELASTICITY AND STRENGTH OF STONEWARE AND PORCELAIN, James E. Boyd

Contributed by the Research Committee

Foundations, Charles T. Main, Mem. Am. Soc. M. E.
Contributed by the Sub-Committee on Industrial Building

Oil Engine Vaporizer Proportions, Louis Illmer, Mem. Am. Soc. M. E.

Thursday Afternoon

This afternoon is left free for excursions. Instead of providing for a large number of excursions, as in previous years, the Local Committee has arranged for a few of exceptional interest which it is expected large groups of members and guests will attend.

Thursday Evening

Annual Reunion, Dinner and Dance at Hotel Astor.

Friday Morning, December 10

Industrial Safety

Standardization of Safety Principles, Carl M. Hansen.

Other papers are expected to be presented on the following subjects: Modern Movement for Safety from Standpoint of Manufacturer; Methods of Reducing Accidents Through Coöperative Movements of Workmen; and Compulsory Compensation for Accidents by Law.

ABSTRACTS OF PAPERS

In the November issue of the Journal brief abstracts were printed of the majority of the papers to be presented at the Annual Meeting. Below are given abstracts of four additional papers which are scheduled on the above program. These abstracts will furnish an idea of the contents of the papers and should be of assistance to members in selecting the papers of interest to them or for purposes of discussion.

HEATING BY FORCED CIRCULATION OF HOT WATER IN TEXTILE MILLS

By Albert Greene Duncan, mem. am. soc. m. e.

This paper treats of the method of using hot water to heat, through direct heating surface, the various rooms of a large textile mill, the water being heated by live or exhaust steam in closed heaters in a central plant, and the hot water being distributed by forced circulation.

The regulation of heat in the various departments is in charge of the power plant engineer, long distance reading thermometers being installed in the power house.

Owing to the configuration of the plant, the heating system was installed in two sections, each section being taken care of by its own heater and pump, and there being a standby unit for emergency.

Since the installation of the system in 1912-13 extensive readings of temperature, humidity, amount of radiation in service, etc., have been made. These records bring out a number of interesting points and show:

a. The benefit of double windows in a plant offsets their cost many times.

b. Openings from heated rooms to entry ways and elevator shafts are a constant source of loss.

c. If study and regulation is made along proper lines, except in extreme weather, heating can be confined to the lower floors of a textile mill, to the weaving and carding departments and to portions of the mill where very little machinery is in operation.

RELATIVE VALUE OF PRIVATE AND PURCHASED ELECTRIC POWER FOR TEXTILE MILLS.

By Frank W. Reynolds, mem. am. soc. m. e. and Dan. Adams, mem. am. soc. m. e.

Average rates for purchased power are higher by a small amount than the cost of generating power in a new isolated plant for a textile mill when there are no adverse conditions. The size of the plant and the load factor have little influence on the relative cost. A fair demand for steam in the process usually gives the isolated plant a decided advantage, but the use of steam for heating and for small demands such as slashing is relatively unimportant. The saving from the use of exhaust steam is apt to be overestimated unless the diversity factor and variable demand are studied carefully.

In the majority of new developments where reliable purchased power is available, the saving from private power will be too small to make the power plant investment attractive. The purchase of power does not wipe out existing fixed charges on a going plant, and therefore cannot compete in power cost with a plant already built, except in the case of additions or extensive renewals or very poor operating economy. The reliability of most purchased power is as good or better than that of an isolated plant without relay capacity.

In general, purchased power is desirable for textile mills, but the desirability must be weighed against the small additional cost in the average case.

A NOVEL METHOD OF HANDLING BOILERS TO PREVENT CORROSION AND SCALE

By Allen H. Babcock.

The author gives an account of the difficulties experienced from corrosion in the boilers of the Fruitvale power house of the Southern Pacific Company, California, which were so serious that in 18 months one-third of the tubes required replacing. Various efforts were made to check the corrosion, without success, until the author learned of the investigations and experiments conducted by Commander Frank H. Lyon, U. S. N., on the treatment of feedwater. This work by Commander Lyon led to the proposal of a compound known as the "Navy Standard Boiler Compound," the main element of which is sodium carbonate, but which contains also trisodium phosphate, dextrine and a tannin compound; and a determination of the effect on corrosion of feedwater having different degrees of alkalinity. The compound was tried out at Fruitvale station with the result that corrosion troubles practically ceased.

A further trial of the compound was made, with favorable results, in one of the worst locomotive water districts on the Southern Pacific Lines, and also in other power plants of the system. An account is given of these experiences and of the modifications made to reduce foaming in locomotive boilers.

The paper outlines the features of the long investigation by Commander Lyon of the causes of corrosion and means for overcoming this trouble, which led to the discovery of the Navy compound. Full directions are given for using the Navy compound.

PERFORMANCE AND DESIGN OF HIGH VACUUM SURFACE CONDENSERS

By Geo. H. Gibson, mem. am. soc. m. e. and Paul A. Bancel, jun. am. soc. m. e.

Heat transmission in surface condensers presents anomalies of which a consistent explanation has not been offered. The coefficients of heat transmission secured in commercial condensers are far short of those realized in experimental laboratory condensers and, moreover, the coefficients obtained under summer conditions are always better than those obtained from the same condensers in winter, with colder circulating water. Examination of a number of tests of condensers with varying conditions shows, however, that the depression of the air pump suction temperature below the steam temperature corresponding to the vacuum is related to the average coefficient of transmission, or relative proportion of the active zone of condensation, in a definite way. This depression is due partly to fall in pressure and expansion of the steam incidental to its flow through the resistance presented by the condenser, and is also implied in the increasing partial pressure of the air as the latter nears the air pump suction opening. If the pressure at the inlet of the condenser is known and the drop can be calculated, the pressure at the air pump suction can be predetermined; and, taking into considerataion the fact that the virtual displacement of the air pump is approximately constant and that the air must therefore be reduced to a fixed volume regardless of vacuum, the temperature of the air pump suction with a given amount of air can be calculated. This, in connection with the inlet steam temperature is, as already mentioned, an indication of the average coefficient of transmission to be expected, which in turn makes it possible to estimate what water temperature will be necessary in order to carry the same load at a different vacuum, or vice versa. For a given condenser, the effects of changes in any of the following factors: load; vacuum; water temperature; rate of flow, and air pump capacity, can therefore be foretold if its performance under one set of conditions is known.

At high vacuums the spacing and the number of rows of tubes, which determine the pneumatic resistance of the steam flow path or paths, have great influence upon the average efficiency of the surface in transmitting heat. Since the controlling resistance is on the air-steam side of the tubes in the air-drowned inactive zone of the condenser, increase in water velocity is of little benefit in these tubes. In fact, this velocity may be decreased and the velocity in the tubes of the active zone increased where it will do some good without added power expenditure. Zone condensers of this kind are illustrated.

COLLEGE REUNIONS DURING THE ANNUAL MEETING

It has been customary during the past few years for the New York Alumni Associations of various colleges where engineering courses are given to hold a reunion on the last evening of the Annual Meeting (which this year will be December 10), to welcome the large number of out-of-town alumni. Complete details of final arrangements will be given in the program distributed at the Annual Meeting. The following reunions have been planned tentatively for that evening:

BROWN UNIVERSITY

The Engineering Alumni of Brown University will hold a reunion in the form of a Smoker. Those desiring to attend are requested to communicate with Mr. Francis P. Davis, care of American Telephone & Telegraph Co., 15 Dey St., New York.

CORNELL UNIVERSITY

Mechanical Engineers from Cornell University have arranged for their annual dinner at the Cornell University Club, 65 Park Ave., New York. Definite details for the program have not yet been decided, but last year's plan of having appropriate special features for the entertainment of those in attendance will be carried out. Further information may be obtained from Mr. F. Kingsley, care of the Electric Railway Journal, 239 West 39th St., New York.

LEHIGH UNIVERSITY

The New York Lehigh Club will hold an informal reunion dinner and smoker at the Machinery Club, Hudson Terminal Building, 50 Church Street, New York, at 6:30 P. M. Mr. Homer D. Williams of the Class of '90 will be the Guest of Honor. Further information may be had from Mr. H. H. Scovil, care of the Railway Steel Spring Co., 30 Church Street, New York.

MASSSACHUSETTS INSTITUTE OF TECHNOLOGY

While no formal reunion has been arranged, the members of the Technology Club will go in a body to the Chemists' Club, 52 East 41st St., New York, where Dr. Richard C. MacLauren, President of Massachusetts Institute of Technology will make an address. On December 11 a luncheon and reception will be tendered to Dr. MacLauren at the Technology Club of New York, 17 Gramercy Park. All "Tech." men are invited to participate in these events. Information will be furnished by Mr. Thomars C. Desmond, 17 Gramercy Park, New York.

POLYTECHNIC INSTITUTE OF BROOKLYN

The Mechanical Engineering Alumni of the Polytechnic Institute of Brooklyn will hold a reunion in the rooms of the Society. An invitation to attend is extended to all members of the Society as well as the Alumni of Polytechnic Institute. Detailed information may be obtained from Mr. H. G. Tyler, Polytechnic Institute of Brooklyn.

PURDUE UNIVERSITY

The Purdue Club of New York will hold an informal reunion dinner and smoker at the Phi Gamma Delta Club, 34 West 44th Street, New York A number of celebrities are expected and all Purdue men are urged to attend. Further information may be obtained from Mr. J. B. Thiess, 463 West Street, New York.

UNIVERSITY OF ILLINOIS

The Alumni of the University of Illinois will hold a reunion dinner and smoker at the Chemists' Club, 52 East 41st Street, New York. Information may be obtained from Mr. J. A. Kinkead, care of the Parkesburg Iron Company, 30 Church Street, New York.

STEVENS INSTITUTE OF TECHNOLOGY

All members of The American Society of Mechanical Engineers and their guests are cordially invited to join with the Alumni of Stevens Institute of Technology in their annual dinner and theatre party on Friday evening, December 10, 1915, at the New Amsterdam Theatre, 42nd Street, west of Broadway. After the show, there will be a supper and dance at the Hotel Astor. Tickets may be obtained from the Tyson Company, Hotel Astor, and further information from Mr. B. Franklin Hart, Jr., 50 Church Street, New York.

WORCESTER POLYTECHNIC INSTITUTE

The New York Alumni of Worcester Polytechnic Institute will hold their Annual Dinner at 6 P. M. at the Hotel St. Dennis, Broadway and 11th Street, New York. Special features are being arranged to make this a "banner" event. Information may be had from Mr. Frank O. Price, Pratt Institute, Brooklyn, N. Y.

REPORTS OF STANDING COMMITTEES

Presented at the Council Meeting, November 12, 1915

REPORT OF THE COMMITTEE ON CONSTITUTION AND BY-LAWS

During the past year the Committee on Constitution and By-Laws has considered matters referred to it from the Council covering the following revisions:

B-27 A Nominating Committee of five members, not members of the Council, shall be appointed before February first of each year by the President. The Secretary shall publish the names of this Committee in the March issue of The Journal, together with a request to the voting membership of the Society that they recommend to the Committee the names of eligible persons for the elective offices to be filled at the next election. This Committee shall deliver to the Secretary in writing between the first and the fifteenth of June the names of its nominees for the various elective offices next falling vacant under the Constitution, together with the written consent of each nominee. The names of the nominees for the various offices proposed by this Committee shall be published by the Secretary under the names of the Committee in the July issue of The Journal.

B-28 A special Nominating Committee, if organized, shall on or before October fifteenth, present to the Secretary the names of its nominees for the elective offices next falling vacant under the Constitution, together with the written consent of each nominee. The names of the nominees for the various offices proposed by this Committee shall be published by the Secretary under the names of this Committee in the November issue of The Journal.

Nominating Committee.

(Proposed) C-48 Special Nominating Committee:

Any group forming one per cent of the persons entitled to vote may constitute itself a Special Nominating Committee, with the same powers as the Annual Nominating Committee appointed by the President.

The proposed amendment to the Constitution was presented at the Spring Meeting in Buffalo and will come up for any suggested revision and amendment at the Annual Meeting in December.

The Committee has under consideration an amendment to By-Law 12 which the Council has requested be brought into harmony with the provisions for the nomination and balloting for officers of the Society.

By-Law 47 is a new By-Law for a uniform policy in the matter of reports of committees.

B-47 All written reports of all committees shall be presented to the Council. Each written report of every Committee must be approved in writing by at least a majority of the members of that Committee, before it is presented to the Council. A member of a Committee who disagrees with the action of a majority of that Committee may express his disagreement over his signature, either on the report of the Committee or in a minority report. The minority report of any member of a Committee if offered, shall be presented at the same itme that the report of that Committee is presented to the Council.

All reports of Committees must be first received by the Council who shall prescribe the manner in which they shall be presented to the Membership of the Society and be made public and printed.

The matter of professional reports has been further considered in a proposed amendment to C-54 of the Constitution to read as follows. This amendment was also presented at the Spring Meeting of the Society:

(Proposed) C-54 The Society shall claim the exclusive copyright to any reports of its duly appointed committees. The Council shall waive such copyright for specific reports. The Society shall copyright all papers read before the Society, printing thereon in each instance that the paper may be reprinted by anyone after the same has been read before the Society, provided that due credit be acknowledged to the Society and the author. The policy of the Society shall be to give the professional and scientific papers read before it the widest circulation possible, with the view of making the work of the Society known, encouraging engineering progress and extending the professional reputation of its members.

Rule 16 is obsolete and has been cancelled, provision being made for it in By-Law 33.

Rule 16—Ballots for amendments to the Constitution shall be canvassed and announced in the same manner as the ballots for officers of the Society.

F. R. Hutton, *Acting Chairman.*

REPORT OF THE FINANCE COMMITTEE

Your Finance Committee reports that the income of the Society for the year ending September 30, 1915, was $147,-628.60. The total expenditures chargeable to income were $118,846.79, leaving an excess over income of $28,781.81. Out of this excess it is necessary to reserve $2,000.00 for completing 1915 condensed catalogues, $100.00 for distributing Vol. 36, Transactions, $200.00 on account of expenses of San

Francisco meeting, leaving a balance of $26,481.81, which we recommend be turned into the Reserve Fund. It is further recommended that all appropriations in excess of actual expenditures be cancelled.

The expenditure of the Society per member for the fiscal year just closed is as follows:

General Salaries	$ 2.24
Rent, library, supplies, etc.	1.73
Committees on Membership and Increase of Membership	1.00
Sections	.56
Employment Bulletin	.18
Council contingencies	.17
House Committee	.27
Annual and Spring meetings	1.24
Year Book	.62
Journal and Condensed Catalogue	6.70
Transactions	1.77
Other activities	1.76
Making a total of	$18.24

The Budget Appropriation for the current year equals per member approximately $20.50.

Your Finance Committee recommends the following budget for the year 1916:

Finance Committee	$29,000.00
Membership Committee	2,000.00
Council	12,200.00
Increase of Membership Committee	6,000.00
House Committee	1,700.00
Meetings Committee	7,850.00
Publications	65,300.00
Research Committee	250.00
Public Relations	500.00
Sales	8,650.00
Student Branches	750.00
Junior Prize	100.00
Total	$134,300.00

The estimated income for the year is placed at $149,570.00.

Appended will be found a report of the accounts of the Society as shown in the books for the fiscal year ending Sept. 30, 1915.

Respectfully submitted,

R. M. Dixon, *Chm.*,
W. H. Marshall,
A. E. Forstall,
Finance Committee.

Mr. R. M. Dixon,
Chairman, Finance Committee

Dear Sir: In accordance with your instructions, we have examined the books and accounts of The American Society of Mechanical Engineers, for the twelve months ended September 30, 1915.

The results of this examination are set forth in the three exhibits, attached hereto, as follows:

Exhibit A Balance Sheet, September 30, 1915.
Exhibit B Income and Expenses for the twelve months ended September 30, 1915.
Exhibit C Receipts and Disbursements for the twelve months ended September 30, 1915.

We hereby certify that the accompanying Balance Sheet is a true exhibit of its financial conditions as of September 30, 1915, and that the attached statements of Income and Expenses, and Receipts and Disbursements are correct.

Respectfully submitted,

Wm. J. Struss & Co.,
Certified Public Accountants.

EXHIBIT *A*

Balance Sheet, September 30, 1915

Equity in Society's Building (No. 25 to 33 West 39th Street)	$353,346.62	
Equity in one-third Cost of Land (No. 25 to 33 West 39th Street)	180,000.00	
		$533,346.62
Library Books	13,000.00	
Furniture and Fixtures	5,000.00	
		18,000.00
Stores, including plates and finished publications		16,128.02
Trust Fund Investment		
New York City 3½'s 1954 (par $45,000)	39,696.81	
St. Louis, Peoria & N. W. 1st 5's 1948 (par $10,000)	10,613.89	
United New Jersey Canal Co. (par $1000)	970.00	
City of East Orange, N. J., Temporary Loan	20,000.00	
Cash in Banks representing Trust Funds	20,703.56	
		91,984.26
Cash in Banks for General Purposes	19,504.00	
Petty Cash, on hand	500.00	
		20,004.00
Accounts Receivable		
Membership Dues	14,165.21	
Initiation Fees	2,150.00	
Sales of Publications, Advertising, etc	25,542.71	
Total		41,857.92
Advance Payments		1,292.50
		$722,613.32

LIABILITIES

Certificates of Indebtedness		$54,100.00
Trust Funds		
Life Membership Fund	$43,500.00	
Library Development Fund	4,902.71	
Weeks Legacy Fund	1,957.00	
Initiation Fee Fund	38,358.90	
Junior & Students Prize Fund	2,000.00	
Melville Fund	1,055.85	
Hunt Memorial Fund	209.80	
Total		91,984.26
Dues Paid in Advance		676.24
Initiation Fees, uncollected		2,150.00
		$148,910.50

Unexpended Appropriation 1913-14.		76
Unexpended Appropriation 1914-15.	1,163.21	
Unapportioned Revenue 1914-15...	27,618.60	
		28,781.81
Capital Investment...............	$497,246.62	
Surplus and Reserve.............	47,673.63	
		544,920.25
		$722,613.32

EXHIBIT *B*

INCOME AND EXPENSES FOR THE TWELVE MONTHS ENDED SEPTEMBER 30, 1915

INCOME			
Membership Dues................		$88,892.87	
Sales—Gross Receipts............		10,612.99	
Advertising		44,766.62	
Interest and Discount.............		3,356.12	
Total................			$147,628.60
EXPENSES			
Finance Committee			
Office Administration.	$18,269.34		
Occupancy Building..	3,600.00		
Library	3,990.53		
		25,859.87	
Membership Committee.		1,842.34	
Council			
Contingencies	$1,432.29		
Local Sections........	3,390.01		
Employment Bulletin.	1,193.82		
		6,016.12	
Increase of Membership Committee.		4,644.62	
House Committee................		1,743.90	
Meetings Committee..............		8,248.50	
Publication Committee			
Advertising	$20,757.27		
Journal Text.........	20,133.38		
Revises	278.00		
Transactions	11,744.12		
Year Book..........	4,026.06		
		56,938.83	
Sales			
General	$5,267.79		
Boiler Code..........	3,958.59		
Power Tests.........	1,042.85		
		10,269.23	
Research Committee..............		20.76	
Students' Committee..............		532.72	
Public Relations Committee.......		471.12	
Junior Prizes....................		5.13	
John Fritz Medal................		79.28	
Engineering Congress............		1,811.45	
Society History..................		362.92	
Total................			$118,846.79
*Excess of Income over Expenses.			$28,781.81

* *Note:* Of this amount, to be reserved for

Completing 1915 Condensed Catalogue...	$2,000.00
Distributing Vol. 36, Transactions......	100.00
San Francisco Meeting................	200.00
Total..............................	$2,300.00

EXHIBIT *C*

RECEIPTS AND DISBURSEMENTS FOR THE TWELVE MONTHS ENDED SEPTEMBER 30, 1915

Membership Dues................	$80,887.95	
Initiation Fees....................	16,940.00	
Membership Dues, paid in advance..	705.19	
Sales of Publications, Badges, Advertising, etc..................	55,174.23	
Interest	4,592.69	
	$158,300.06	
Cash on Hand and in Banks General and Trust Funds, September 30, 1914..............	39,852.33	
		$198,152.39
DISBURSEMENTS		
Disbursements for General Purposes	$131,244.83	
City of East Orange, N. J., Loan..	20,000.00	
Certificates of Indebtedness Redeemed	6,200.00	
	$157,444.83	
Cash on Hand and in Banks General and Trust Funds, September 30, 1915..............	40,707.56	
		$198,152.39

REPORT OF HOUSE COMMITTEE

During the year the portraits of honorary members have been completed and hung in the rooms of the Society. The inventory of pictures, books, publications, stores and equipment has been brought up to date.

Sufficient funds have been saved from the Committee's appropriation to replace on an advantageous basis the worn-out typewriters with new ones, also to provide a metal fire-proof cabinet for the safe keeping of the card records of accounts of members.

Inasmuch as certain members have criticized the Society for not having a special room for out-of-town members to be used for special work, the Committee has provided for all conceivable present demands by the use of the Council room, and until greater demand is made for an additional room with the special purpose of serving out-of-town members, the Council room will be used for that purpose.

Plans have been prepared and estimates secured for the removal of partitions in rooms Nos. 1109 to 1112, so as to make one large room, providing more room and a more efficient arrangement for the members of the staff. Recommendations have been made to the Council for the necessary appropriations to execute this work.

Estimates have also been secured for enlarging the doorways between the elevator entrance corridor and the Council room, and the room adjacent to the Council room. Estimates have also been secured for re-decorating and re-arranging the elevator corridor of the Society.

It is believed these changes will add to the cheerfulness and usefulness of the Society's rooms.

The Society's property in charge of the Committee has been maintained to its previous high degree of permanency

in so far as the funds at the disposal of the Committee will permit.

S. D. Collett, *Chmn.*
W. N. Dickinson
F. A. Scheffler
J. W. Nelson
O. P. Cummings
House Commitee

REPORT OF THE LIBRARY COMMITTEE

During the year ended September 30, 1915, there have been added to the library of the Society 775 volumes and 65 pamphlets. Two large collections have been presented to the Society; the first, the library of the late Horace See, Past President of the Society, a leading naval architect and marine engineer, was presented by John Philp, and comprises a large number of volumes on naval architecture and marine engines. The second, recently received as a gift from the widow of David N. Melvin, is the general library of a working engineer, especially strong in applied chemistry.

During the year the management of the library has been taken over by the United Engineering Society. All purchased books and periodicals will be the property of the United Engineering Society; gifts will be, as formerly, the property of the Founder Society to which the gift is made.

The United Engineering Society has established a Library Service Bureau, to have sole charge of the research work for out-of-town members. This Bureau, self-supporting, will conduct researches, make translations, copies and abstracts, at a charge covering the cost.

The Catalogue of Technical Periodicals in the Libraries of New York and vicinity has been published, as the first bibliographical contribution from the library, and has received favorable comment from engineers, librarians, and the technical press.

The attendance during the year was 12,749. The extension of the evening hour of closing from nine o'clock to ten o'clock has been welcomed by our readers.

During the year additional shelving to accommodate 20,000 volumes has been added; wooden cases for the storage of periodicals awaiting binding have also been purchased.

Respectfully submitted,

Leonard Waldo, *Chmn.*
Jesse M. Smith
W. M. McFarland
J. W. Lieb
The Secretary
Library Committee

REPORT OF THE COMMITTEE ON MEETINGS

The Meetings Committee has met five times since the Annual Meeting of 1914, and will probably have several more committee meetings before the next Annual Meeting of the Society.

The movement inaugurated last year to complete the work of preparation for each meeting of the Society earlier than in former years has not been carried on with entire success, although some measure of progress has been achieved. It appears to be difficult to impress upon those not having had experience with meetings, the time necessary to pass upon, put in type, properly read proof and prepare illustrations for papers.

Three of the papers, out of five provided for the extra meeting in September were received late, and at a time when several members of the Meetings Committee and of the Society staff were not readily accessible, owing to the vacation habit. This situation made it necessary to put these papers in type before submitting them to the committee for approval and did not permit adequate time for revision. One paper which was deemed to need considerable revising could not be returned to its author for revision. The Editor did this work, but it is to be regretted that the author could not have been given an opportunity to do this himself. The time required for communication with San Francisco aggravated the situation in this instance.

A time limit should be fixed for receipt of papers from local committees and, upon its expiration, the Meetings Committee should proceed to complete the program, substituting for those expected, but not in hand other papers if necessary or desirable in its judgment.

The Annual Meeting for 1914 had the largest attendance in the history of the Society. The features of the convention were an all-day meeting on the general subject of the Engineer in Public Service, at which nine papers were presented through the efforts of the Public Relations Committee; a series of largely attended conferences for the discussion of the report of the Boiler Code Committee; and whole sessions by the Railroad and Iron and Steel Committees.

The Spring Meeting was held June 22 to 25, all sessions being held in Buffalo except that of Wednesday, June 23. This session, which included the business meeting, was held at Niagara Falls. Committee reports and professional papers were also presented at this session. On Wednesday evening an admirable illustrated address was delivered by Dr. F. H. Newell on The Engineer as a Citizen.

There were two simultaneous sessions Thursday morning for presentation of papers and a final one Friday forenoon.

The formal social feature was the reception and dance on Thursday evening, but the local committee provided in many other ways for the pleasure of the visiting members, their families and guests. The excellent arrangements for sightseeing and professional inspection trips at Niagara and in Buffalo contributed greatly to the success of the meeting.

In conformity with the other national societies a meeting was held in San Francisco preceding the International Engineering Congress and thirty-five of our members joined the party on the Engineers' special train for San Francisco. The committee was fortunate in securing two authoritative papers on the engineering features of the Exposition and the exhibits. Two papers were presented upon the oil engine, of general interest on the Pacific Slope, and one on the strength of gear teeth.

Plans are fairly well advanced at this time (September 1915) for the Annual Meeting to be held in December.

Enough papers are now in hand for four general sessions. A special session on Industrial Safety is to be arranged by the Sub-Committee on Protection of Industrial Workers. The Hon. John Price Jackson of that committee has consented to take the lead in arranging the program. The sub-committees on Machine Shop Practice, Textiles, and Railroads are each planning for sessions.

The sub-committees of the Meetings Committee have been reorganized. Two of these, for which there seems to be little work at present, have been discontinued, namely, those on Administration and Iron and Steel. In the case of some others, the chairman or other members have changed.

The Committee feels that special efforts should be made to

maintain the interest of engineers in the varied lines of work comprised in the membership and particularly of those who are so situated that their personal participation in the meetings is not practicable. The suggestion in this connection is submitted for consideration of the Council, that a larger number of papers be published by the Society, and that the publications may include some papers to be printed, with written discussion, which will be read by title only at the meetings. This will make it possible to place on record the results of research or analysis of permanent value, although the character of these papers may not be such as to make their oral presentation at a meeting of general interest to the membership at large. It is realized that this project involves larger expenditures, and owing to this the Meetings Committee does not venture to urge it upon the Council, but considers it a duty to present the question for consideration.

Respectfully submitted,

John H. Barr, *Chm.*,
H. E. Longwell,
H. L. Gantt,
R. H. Fernald,
L. P. Alford,
Committee on Meetings.

REPORT OF COMMITTEE ON MEMBERSHIP

The Committee on Membership held nine meetings during the year 1914-1915.

The number of applications considered in the transaction of its work and a summary showing the action taken, follows:

Applications pending Oct. 1, 1914	191
Applications received during fiscal year	1069
Total	1260

The following action was taken on these applications:

Recommended for membership	736
Withdrawn for various reasons	2
Deferred indefinitely	13
Denied promotion	3
Deferred for special investigation	14
In regular course of procedure	492
Total	1260
Reinstatement deferred	1
Reinstatements and Reconsiderations pending	11

Those recommended for membership were divided into the following gradings:

Members	271
Promotion to Member	23
Associates	38
Associate-Members	191
Promotion to Associate-Member	18
Juniors	195
Total	736

The reinstatement of nine members was recommended to the Council.

George A. Orrok, who was appointed a member of the Committee at the beginning of the year, found it necessary to resign and the Committee accepted his resignation with much regret. Dr. Charles E. Lucke accepted an appointment to serve the balance of Mr. Orrok's term, though it was necessary for him to make considerable personal sacrifice in order to serve the Society in this capacity.

Respectfully submitted,

W. H. Boehm, *Chmn.*
H. C. Meyer, Jr.
L. R. Pomeroy
Hosea Webster
Charles E. Lucke
Membership Committee

REPORT OF THE PUBLICATION COMMITTEE

In the last annual report of the Publication Committee, there was a discussion of plans which had been proposed for eliminating the duplicate publication of papers in Transactions and The Journal. During the previous year The Journal had been published in a form whereby it could be bound at the end of the year and constitute the Transactions of the Society. At the same time, the advance papers for meetings were printed in pamphlet form as usual, for which the type was held to permit the publication of the annual volume of Transactions in the 6 by 9 library size.

In view of letters of criticism and suggestions received from the membership, it was evident that there was a very earnest desire on the part of many members to have the Transactions continued as a separate volume, and accordingly, by direction of the Council, Volume 36 was issued, leaving no break in the continuity in the series of these volumes.

The decision to issue Volume 36 of Transactions and the possibility of the continuance of Transactions led to a change in the presentation of matter in The Journal, in that the Annual and Spring meeting papers, which go to the entire membership in complete form in Transactions, and are available at all times in pamphlet form to those who desire them, have been condensed as published in The Journal. The Journal serves the purpose of a current periodical which contains accounts of meetings immediately after the meetings have been held.

On the other hand, the papers presented at local meetings of the Society, which, as a general thing, have not been included in Transactions, have had more complete publication in The Journal. Every effort has been made to render comprehensive reports of these local meetings.

The publication plan which has been followed the past year is as follows:

1. Advance copies of papers for Annual and Spring meetings printed in pamphlet form (6 by 9 size).
2. Very brief abstracts of these papers appear in The Journal previous to the meeting with the statement that pamphlet copies will be sent free to any member asking for them.
3. After the meeting a running account of the proceedings of the meeting is published in The Journal, which includes copious abstracts of the papers and discussion.
4. The complete papers for the Annual and Spring meetings are published in the annual volume of Transactions. When this volume is printed additional sheets are run on the press and bound up in pamphlet form as revises, which are placed in the stock room for future sales.
5. Papers presented at local meetings are published in The Journal in either abstracted or complete form.

The following resolutions have been adopted by the Com-

mittee and with the approval of the Council will constitute the policy of the Publication Committee for the ensuing year. It was moved that the Publication Committee recommend to the Council:

TRANSACTIONS

1. That the publication of the annual volume of Transactions be continued.
2. That it be published in the same size and binding as heretofore.
3. That it shall contain, subject to the approval of the Publication Committee, all of the papers and discussions presented at meetings of the Society (not including section meetings), and technical reports of Committees; and shall contain a syllabus of each paper, summarizing the essential facts and conclusions.
4. That it shall contain all the papers and discussions presented at section meetings which in the opinion of the Publication Committee are of sufficient merit.

REVISES

That additional revised copies of the papers and discussion be printed and bound in pamphlet form at the earliest practicable date. A charge will be made for such pamphlets.

ADVANCE PAPERS

That papers for the meetings of the Society be printed in pamphlet form in advance, as heretofore, and be sent to members gratis upon request, a notice of these papers with syllabi, being printed in The Journal one month before meetings.

THE JOURNAL

1. That The Journal be published monthly as heretofore, but with the view to making it a semi-monthly or a weekly as soon as the amount of matter to be handled requires it and funds for that purpose are available.
2. That the size of The Journal shall for the present remain as it now is.
3. That The Journal shall contain:
   - *a* All of the papers and discussion presented at regular meetings of the Society, preferably in substantially complete form, or adequately abstracted, according to the character of the paper, as soon after the meetings as possible.
   - *b* Papers, or abstracts, with discussion, presented at meetings of Local Sections.
   - *c* Announcements and reports upon Society affairs and incidents, employment bulletin, library notes, personal notes, etc.
   - *d* Department for contributed discussions on papers previously published, or new matter.
   - *e* Members correspondence department, including suggestions on Society affairs.
   - *f* Review of World's Technical Press.
   - *g* Review of technical books, by experts selected by the Committee.

The Committee adopt as a policy that the Editor shall coöperate with the author to present all papers and discussions as concisely as possible, consistent with clearness and completeness. This not only adds to the utility of the paper, but will make possible the publication of more papers in complete form. An abstract should be done by the author. The editor will coöperate toward securing uniformity.

The practice has been to publish the papers in Transactions in full. In The Journal the present practice is to reduce the papers and discussion by abstracting about 50 per cent. To have published them complete in The Journal during the past year would have cost $3000 additional.

The Committee believes that the members will be best served by publishing papers in The Journal in substantially complete form, and that the additional cost of approximately $3000 would be fully justified by the enhanced value of The Journal.

The Committee, however, would make an exception of certain types of papers—notably voluminous research papers which may be more acceptably presented in abstract.

The point is often raised that there would be economy in printing The Journal and Transactions with the same size page to avoid the necessity of resetting the type. The 6 by 9 size is undoubtedly more acceptable to the members for Transactions and for the advance papers than the 9 by 12 size would be, and the 9 by 12 size is far more advantageous for The Journal, both on the score of greater income from advertising and lower cost of production.

An examination of the bills for the last volume of Transactions shows the additional cost per page for resetting the type to be $0.75. The cost for the total edition delivered to the members is $10.00 per page. The additional cost, therefore, for resetting amounts to $7\frac{1}{2}$ per cent.

There are practical reasons, such as the wear of the type on a long run of The Journal and the uneven appearance of Transactions printed from worn type on which corrections have been made, and differences in the make-up of The Journal and Transactions which have a bearing on the matter and which should be considered as well as the cost.

A year ago, on account of depressed business conditions resulting from the war in Europe, it was anticipated that there might be a reduction in the income in advertising which would necessitate curtailment in the production of The Journal. These fears, however, have proved to be groundless since the year has proved to be the most successful one for The Journal and the income which has been turned back into the publication for the benefit of the membership has been the largest in its history.

An appropriation has been asked for printing an index to the first 30 volumes of Transactions this coming winter.

The following is a statement of the budget for the past year and of the actual income and expenses:

STATEMENT OF THE BUDGET FOR THE PAST YEAR AND OF THE ACTUAL INCOME AND EXPENSES

	Budget for 1914-15		Actual Income	Actual Expenses
	Income	Expenses		
Journal				
Text.......	....	$21,000	....	$20,133.38
Advertising.	$40,000	18,600	Cond. Cat. $20,690.64 Journal $24,075.98	Cond. Cat. $7,705.28 Journal $15,051.99
Transactions..	....	11,000	....	11,844.12
Revises......	....	500	....	278.00
Year Book....	....	4,400	....	4,026.06
Total......	$40,000	$55,000	$44,766.62	$59,038.83

REPORT OF THE RESEARCH COMMITTEE

I take pleasure in presenting the following report of the Research Committee of the Society for the year 1914-15.

The members of the Research Committee for the year have been as follows:

R. C. Carpenter, *Chairman*
R. H. Rice
R. D. Mershon
R. J. S. Piggott
A. M. Greene, Jr.

The Committee has held various meetings during the year, and has devoted a considerable amount of time to the promotion of various lines of investigation which have been referred to them, and has undertaken to stimulate further investigation by the appointment of sub-committees for special lines to work.

The Committee on Research was founded very largely as a result of efforts by the late C. W. Hunt, Past President of the Society. The first members were appointed by the late Col. E. D. Meier, Past President. The duty of the Committee as stated at the time of its appointment was to consist of work relating to the promotion of investigation, and of recording the results of investigation in the records of the Society where they would be useful for the engineering profession.

During the year the Committee has formulated concisely the field of work which it believes it should undertake, and in which there seems to be a demand for united effort, for the purpose of promoting investigations. As the result of careful consideration, the following statement as to the object of the Research Committee was agreed to unanimously:

> The object of the Research Committee is to promote the investigation of phenomena, operations or results of experiments concerning fundamental laws on which engineering practice may be based, and to place such data in permanent and basic form.

For the purpose of promoting investigation it was decided some years ago to form sub-committees consisting of eminent specialists in the particular subject under consideration, and this duty has constituted the principal activity of the Committee.

The following sub-committees have been appointed and all report progress in the particular field which has been referred for their consideration:

Sub-Committee on Fuel Oil
R. H. Danforth, *Chairman*
A. M. Hunt
L. E. Barrows
Ervin G. Bailey, resigned (accepted August 14); vacancy not filled

Sub-Committee on Materials of Electrical Engineering
R. D. Mershon, *Chairman*

Sub-Committee on Safety Valves
E. F. Miller, *Chairman*
P. G. Darling
H. D. Gordon
F. L. Pryor
F. M. White

Sub-Committee on Steam
R. H. Rice, *Chairman*
C. J. Bacon
E. J. Berg
W. D. Ennis
L. S. Marks
J. F. M. Patitz

Sub-Committee on Clinkering of Coal
L. S. Marks, *Chairman*
F. C. Hubley
A. V. Bleininger
O. P. Hood
O. W. Palmenberg
S. W. Parr

The appointment of other sub-committees is under consideration is as follows:

Sub-Committee on an investigation of worm gearing. F. A. Halsey has taken a great amount of interest in this and has already done a large amount of commendable work. This investigation will require a considerable amount of time and quite a large investment in order to carry it through properly. It is believed that arrangements will be made for carrying out this investigation under the leadership of Mr. Halsey, who is willing to devote his personal time to the investigation without compensation. A sub-committee has been suggested, but it has seemed desirable to await further developments before making definite appointments.

Sub-Committee on Lubrication. The appointment of this sub-committee has been urged by a letter to the Council by F. zur Nedden, and several other prominent members of the Society. The Bureau of Standards, Washington, D. C., has expressed a willingness to carry out investigations along this line, and for that reason the Research Committee believes that a large amount of valuable data and practical useful information can be secured. A paper on this subject was read before the Society by M. D. Hersey of the Bureau of Standards, which points out many promising lines of research open to investigation. The Committee on Research will without doubt appoint a sub-committee on Lubrication to coöperate with the Bureau of Standards.

Sub-Commitee on Research Relating to Machine Tools. This line of investigation was started some years ago by the National Machine Tool Builders Association in charge of a committee consisting of L. P. Alford, A. L. De Leeuw, J. B. King, E. R. Norris and Chas. Mills, and a considerable amount of money was expended in the building of a dynamometer. This association decided to abandon this line of technical investigation and recommended that the activity be transferred to The Am. Soc. M. E. Dr. Stratton, of the Bureau of Standards, has expressed a willingness and a desire to coöperate with The American Society of Mechanical Engineers in carrying out investigations along the line proposed by the technical committee relating to machine tools. It has been proposed to appoint as the sub-committee in charge of the machine tool investigation the members of the previous committee who are all connected with The American Society of Mechanical Engineers (which will include all excepting J. B. King) and to add to the commitee some member of the Bureau of Standards in order to get the advantage of the laboratory connected with the Bureau and also the advice and assistance of Dr. Stratton and others. Secretary Rice has already corresponded with Director Stratton as to the field of work which the Bureau of Standards and The American Society of Mechanical Engineers can take up jointly with good chances of success.

Sub-Committee on Laboratory Equipment and Methods of Investigation. The appointment of a sub-committee which should consist of the directors and scientific investigators in

the college and other laboratories has been proposed and is under consideration by the Committee. It is expected that a sub-committee with membership as stated above would be able to bring about coöperation of the various laboratory plants of engineering colleges and would result in scientific arrangement of laboratory research and ensure to the Society the results of investigations possible with the equipment and staff of such laboratories. It has been suggested that a meeting for such a sub-committee be called at the time of the coming Annual Meeting in December.

The Sub-Committee on Safety Valves has been the means of obtaining several papers on this subject which have appeared in the Transactions of the Society. The investigations made by Prof. E. F. Miller are notably of great value, and have formed the basis for standardizing the safety valve practice and construction, which was formulated as a result of very extended consideration by the Boiler Code Committee jointly with the manufacturers of safety valves.

R. D. Mershon has been actively engaged in obtaining data as to the strength of electrical engineering materials and has succeeded in getting the coöperation of Prof. Orton and Prof. Boyd of the Ohio State University at Columbus. The result of this investigation is a paper by Professor Boyd, which will be read at the Annual Meeting of the Society. This is believed to give the first reliable results of the strength of ceramic materials and adds valuable data to the records of the Society.

Prof. L. S. Marks has undertaken the important work of determining the character and amount of waste in the combustion of coal which results in the production of clinkers. His sub-committee reports progress. During the coming year, I believe a considerable amount of useful data will be obtained which will serve as a basis of extended papers before the Society.

The Research Commitee is hampered to a considerable extent by the fact that the fund available for promotion of investigation is small, and it has not been considered desirable to undertake any line of work, no matter how desirous or how promising, because of the need of financial backing, which was not, under present conditions, assured.

The Committee expresses confidence that at some time in the future funds may be available for the expense of promoting investigations and for making proper records and deductions from such investigations, which can be put in a condition available for the practical guidance of engineering construction.

Respectfully submitted,
ROLLA C. CARPENTER, *Chairman.*

REPORT OF PUBLIC RELATIONS COMMITTEE

The Standing Committee on Public Relations was first appointed about 1910, following the Washington Meeting at which the Constitution was amended to make provision therefor. It would appear that for the first few years after appointments were made no special action was taken by the Committee, although there were during this period some minor references made to it by the Council.

An appropriation of $500 was made for the first time this year to cover the activities of the Committee. Following out the evident desires of the Society as shown by this Committee, a Public Service Session was planned and held in connection with the Annual Meeting in New York in 1914. This session was addressed by his Honor the Mayor of New York, John Purroy Mitchell; by the then President of the Society, James Hartness, and by the President-elect, John A. Brashear, and by Andrew Carnegie. The following papers covering various parts of the field of Municipal Engineering were presented and ably discussed:

The Future of the Police Arm from an Engineering Standpoint, by Henry Bruere
Snow Removal, by Intercity Committee on Snow Removal
The New Charter for St. Louis, by Edward Flad
The Engineer and Publicity, by C. E. Drayer
The Handling of Sewage Sludge, by George S. Webster
Some Factors in Municipal Engineering, by Morris L. Cooke
Training for City Employes in the Municipal Colleges of Germany, by Clyde Lyndon King
The Design and Operation of the Cleveland Municipal Electric Light Plant, by Frederick W. Ballard
A Study of Cleaning Filter Sands with no Opportunity for Bonus Payments, by Sanford E. Thompson.

The attendance at this session, the interest shown by the discussion and the demand there has been for the papers presented, all demonstrate that in carrying out this plan, a valued public service was rendered.

During the year a number of important references from the Council have been acted upon. The whole drift among engineers individually and as members of technical societies is toward a larger participation in public affairs. There are certain classes of activities that apparently fall clearly within our field and which we should undertake—activities which will be carried on by those poorly qualified to handle them if our profession fails to meet its opportunities. On the other hand, demands for our coöperation in increasing number will be made upon us that should be just as clearly declined. Without more experience than we have thus far had, it would be premature to make any hard and fast rules in this connection.

Among the subjects which have received favorable report of your Committee and which have later been endorsed by Council, are the participation by our Society in the activities of a joint inter-technical society committee to study the question of expert testimony and the methods under which it should be given. We also advised the appointment of delegates from our Society to serve on a joint committee made up of representatives from different engineering societies to assist the National Government in preparations for the engineering branch of a military reserve. The Committee under the able chairmanship of William Barclay Parsons has been in constant conference with the national authorities for months past. Delegates have also been appointed to serve on a board of engineers which made suggestions on engineering matters to the New York State Constitutional Convention.

It is believed by your Committee that if our Society can take up such lines of activity in fields obviously our own that we may develop methods of service of benefit to our Government—federal and state—as well as to the profession. To withhold such activity on narrow grounds would appear to be ill-advised.

MORRIS L. COOKE, *Chmn.*
GEORGE M. BRILL
JAMES MAPES DODGE
SPENCER MILLER
WORCESTER R. WARNER
Public Relations Committee

COUNCIL NOTES

At the meeting of the Council on November 12, 1915, the following members were present: John A. Brashear, *President*, H. L. Gantt, R. M. Dixon, *Chairman, Finance Committee*, D. C. Jackson, A. M. Greene, Jr., Henry Hess, Spencer Miller, James E. Sague, Frederick R. Hutton, William H. Wiley, *Treasurer*, C. T. Main, E. E. Keller, and Calvin W. Rice, *Secretary*.

A special order of business was the consideration of the report of the Administration Committee. After an extended discussion, the Committee was invited to take into consideration the various suggestions of the members of the Council, and to frame recommendations in accordance with the views expressed.

The reports of the Standing Committees were presented and were ordered printed in this issue of The Journal and distributed at the Annual Meeting.

The appointment was announced of Ambrose Swasey as the representative of the Society at the Pan-American Scientific Congress and W. H. Marshall as alternate, in response to the invitation of the Department of State of the United States; and the announcement was made of the selection by the Secretary of State of Dr. John A Brashear as the representative of the engineering profession in America to the Congress. E. M. Herr was appointed as the Society's representative at the celebration of Carnegie Day, November 23, commemorating the eightieth birthday of Mr. Carnegie.

Prof. Frederick R. Hutton presented a copy of the Society History, and announced the completion of its publication. A vote of thanks was tendered to him and to those who had assisted him in its preparation.

Interpretations of the Boiler Code were on motion received, ordered issued and published in The Journal.

The appointment of E. Howard Reed as Chairman of the Worcester Committee on Increase of Membership was confirmed.

It was voted to receive the report of the Committee on Threads for Fixtures and Fittings. This report will be printed and distributed and open for discussion at the business session, Wednesday morning, of the Annual Meeting.

It was voted to approve the exchange of house and library privileges with the Engineers' Club of Kansas City.

Calvin W. Rice,
Secretary.

AN EMINENT PENNSYLVANIAN

[Editorial from The Pittsburgh Gazette]

In the proposal by a group of prominent Pittsburghers to honor the 75th birthday anniversary of John A. Brashear on November 24, there is exhibited a fitting sense of the long and valuable services of this truly eminent citizen of Pittsburgh and of the State of Pennsylvania. To be the chief guest at a banquet is not an uncommon mark of distinction or of friendship, but in any effort, great or small, to honor Dr. Brashear, there will enter an element of universal approval that sets it apart from any like demonstration. As a scientist, as a citizen and as a brother to all men, John A. Brashear holds a peculiar place in the history of Pittsburgh and in the affection and esteem of his fellow citizens. His rise from obscurity to a place of authority and world-wide usefulness in the field of astronomical invention, and the story of his early struggles and patient endeavor to overcome the obstacles in his path, are parts of the history of Pittsburgh of which every man, woman and child, perhaps, has read and is proud.

His amiability, his thousand unheralded acts of philanthropy and his benign, cheery disposition are things that his more intimate friends know. He is "Uncle John" to hundreds of people still obscure in life and the simplicity and democracy of his association with his fellowmen have won him the deepest affection of old as well as young. To give John A. Brashear a banquet seems, in view of all that he is and has done for the world, a trivial compliment to a great man, but it carries with it the affectionate hope that the 75th anniversary of his birth may find him hale, happy and hearty and with many more ripe and peaceful years in which to enjoy the companionship of those who love him for the man he is and honor him for the service he has given to the city, the state and the world.

NAVAL CONSULTING BOARD

The second meeting of the civilian Naval Consulting Board took place in New York City on November 4, when the board was divided into sixteen Committees, each to deal with its own special problems. The names and personnel of these committees are as follows:

Chemistry and Physics. W. R. Whitney, *Chairman*, Lawrence Addicks, L. H. Baekeland, Joseph W. Richards, M. B. Sellers, A. G. Webster, R. S. Woodward.

Aeronautics, Including Aero Motors. Henry A. Wise Wood, *Chairman*, Howard E. Coffin, P. C. Hewitt, Andrew L. Riker, M. B. Sellers, E. A. Sperry, A. G. Webster.

Internal Combustion Motors. Andrew L. Riker, *Chairman*, Howard E. Coffin, M. B. Sellers, E. A. Sperry.

Electricity. Frank J. Sprague, *Chairman*, Lawrence Addicks, William Le Roy Emmet, P. C. Hewitt, B. G. Lamme, A. G. Webster.

Mines and Torpedoes. Elmer A. Sperry, *Chairman*, L. H. Baekeland, M. R. Hutchison, Hudson Maxim.

Submarines. William Le Roy Emmet, *Chairman*, A. M. Hunt, M. R. Hutchison, W. L. Saunders, Frank J. Sprague.

Ordnance and Explosives. Hudson Maxim, *Chairman*, L. H. Baekeland, A. M. Hunt, M. R. Hutchison, Frank J. Sprague, A. G. Webster, W. R. Whitney, Henry A. Wise Wood, R. S. Woodward.

Wireless and Communications. P. C. Hewitt, *Chairman*, A. G. Webster, W. R. Whitney.

Transportation. Benjamin B. Thayer, *Chairman*, Howard E. Coffin, Alfred Craven, Spencer Miller, A. L. Riker, Thomas Robins, W. L. Saunders, Henry A. Wise Wood.

PRODUCTION, ORGANIZATION, MANUFACTURE AND STANDARDIZATION. Howard E. Coffin, *Chairman*, Lawrence Addicks, William Le Roy Emmet, B. G. Lamme, Thomas Robins, W. L. Saunders, Benjamin B. Thayer.

SHIP CONSTRUCTION. Frank J. Sprague, *Chairman*, Spencer Miller, Joseph W. Richards, Henry A. Wise Wood.

STEAM ENGINEERING AND SHIP PROPULSION. Andrew M. Hunt, *Chairman*, William Le Roy Emmet, B. G. Lamme, Joseph W. Richards, M. B. Sellers.

LIFE SAVING APPLIANCES. Spencer Miller, *Chairman*, Hudson Maxim, Thomas Robins.

AIDS TO NAVIGATION. Elmer A. Sperry, *Chairman*, Alfred Craven, A. M. Hunt, Henry A. Wise Wood, R. S. Woodward.

FOOD AND SANITATION. L. H. Baekeland, *Chairman*, Hudson Maxim, Benjamin B. Thayer, W. R. Whitney, R. S. Woodward.

PUBLIC WORKS, YARDS AND DOCKS. Alfred Craven, *Chairman*, Lawrence Addicks, A. M. Hunt, Spencer Miller, Joseph W. Richards.

Dr. M. R. Hutchison, Mem. Am. Soc. M. E., of Llewellyn Park, West Orange, N. J., has been appointed on the Board by Secretary Daniels. He is included above in the Committees on Submarines, Mines and Torpedoes, and Ordnance and Explosives.

INTERNATIONAL ENGINEERING CONGRESS

The volumes of Transactions of the International Engineering Congress, shortly to be issued, will be worthy of a place in the library of any member of the Society. Many of the papers are monumental, and the scope of practically each one is a review of recent signal work in the field to which it relates, as well as a discussion of the lines of future development. Collectively, the papers therefore represent the status of engineering in 1915. Many of them contain bibliographies of their subjects, which are invaluable for reference purposes.

The Committee of Management of the Congress reports that, on October 1, over 3,500 engineers and others had subscribed for volumes, and that subsequently 1,500 had ordered an average of 2.25 extra volumes each.

The Congress now extends an invitation to any who have not yet done so to subscribe to one or more of the volumes of Transactions of which there are eleven, as follows: The Panama Canal, Waterways and Irrigation, Municipal Engineering, Railway Engineering, Materials of Engineering Construction, Mechanical Engineering, Electrical Engineering and Hydroelectric Power Development, Mining Engineering, Metallurgy, Naval Architecture and Marine Engineering, Miscellaneous, including Aeronautics, Refrigeration, Agricultural Engineering, Engineering Education, Heating and Ventilation, Scientific Management.

Each volume is complete in itself and may be subscribed for separately, or a number of volumes or complete sets may be obtained. The contents of the volumes are substantially as given in the September number of The Journal, in which an advance program of the Congress was published. A subscription form which may be used when ordering volumes is given in the advertising section of this issue.

The Congress was organized and conducted under the auspices of the American Society of Civil Engineers, American Institute of Mining Engineers, American Institute of Electrical Engineers, Society of Naval Architects and Marine Engineers, and this Society.

CONGRATULATIONS TO PHILADELPHIA

Philadelphia, always dominant in engineering, has now demonstrated that her engineers are supreme as engineers of men as well as of things. During five days of the past month, the members of the Engineers Club of Philadelphia conducted a whirlwind campaign for new members. Starting with a membership of 551, it was expected that 1000 new members would be added. A corresponding reduction in dues was planned, based on a sliding scale in proportion to the number of members. Quoting from the Philadelphia Ledger:

> The red paint that fills the immense thermometer in the Engineers' Club, marking the progress of the club's campaign for new members, who are to make Philadelphia the engineering center of the East, splashed over the thermometer's top yesterday, and the campaign, with 24 hours yet to go, was pronounced a huge success. In four days the club had recruited 990 new members, raising its total membership to 1541. Another record was broken in membership campaigns yesterday, when 331 technical men joined the organization. The campaigners were so enthused with their success that they set themselves a new goal. By noon to-day they expect the total of new members will reach 1250.

And this total was not only reached, but far exceeded. At the end of the five days 1672 members were added, making a grand total of 2,223. This is the largest membership of any Engineers' Club in the country, exceeding that of the Engineers' Club of New York by over 100, and resulting in a prospective reduction of dues from $35 to $15 per year. Many members of the local sections of the national societies are also members of the Engineers' Club, indicating the spirit of coöperation which exists. The sections represented include The American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, the American Society of Illuminating Engineers, the local body of the Society of Automobile Engineers, and the local Technology Club of the Mass. Inst. of Technology.

INAUGURATION AT LAFAYETTE

Dr. John Henry MacCracken, former syndic and professor of politics, New York University, and an educator in philosophy, was inaugurated president of Lafayette College on October 19. The Society was represented at the exercises by William R. Dunn, Mem. Am. Soc. M. E., and two hundred colleges sent delegates.

The programme included a conference on Educa-

tional Problems of Lafayette College, an inaugural dinner, an academic procession and the conferring of nineteen honorary degrees.

REPRINT OF REPORT OF JOINT COMMITTEE ON STANDARDS FOR GRAPHIC PRESENTATION

Owing to the heavy demand for copies of the Report of the Joint Committee on Standards for Graphic Presentation, a second edition of the reprint of the Report as it appeared in the Journal of August, 1915, page VII, became necessary. As a result, the Report has been reprinted in the form of a 6 x 9 inch pamphlet of 8 pages, in which the illustrations have been remade to a uniform size and somewhat larger, to facilitate study of the diagrams and reproductions therefrom. The price of the pamphlet remains at 10c. per copy.

PROMULGATION OF THE BOILER CODE BY THE AMERICAN UNIFORM BOILER LAW SOCIETY

For the purpose of cooperative effort, leading to the introduction of the Boiler Code formulated by the Boiler Code Committee of the American Society of Mechanical Engineers early this year, an organization has recently been formed under the name of The American Uniform Boiler Law Society. This society, which has ambitious plans for extending its work into every state in the Union, is composed of representatives of all the industries connected in any way with steam boiler construction or operation. These industries and the men representing them are as follows:

Tubular Boilers	Thomas E. Durban
American Boiler Manufacturers Asse'n	E. R. Fish
National Asse'n of Thresher Manufacturers	H. P. Goodling
National Boiler & Radiator Manufacturers Asse'n	F. W. Herendeen
Low Pressure Steel Boiler Manufacturers	M. F. Moore
Water Tube Boiler Manufacturers	I. Harter, Jr.
Locomotive Manufacturers	John Wynne
Steam Shovel Manufacturers	Walter Plehn
Hoisting Engine Manufacturers	H. N. Covell
Boiler Insurance Companies	Chas. S. Blake
National Electric Light Asse'n	John Hunter
Boiler Materials	D. J. Champion

The above representatives form the administrative council of the Society, of which Thomas E. Durban has been appointed chairman. In order to defray the expenses incurred in the work of promulgation, an annual subscription, in varying amounts, has been made by the above industries through their representatives, amounting in total to $12,000. It is proposed to expend at least this amount annually in the effort to secure uniformity of boiler laws throughout the United States and neighboring countries.

The council and chairman are anxious at all times to receive suggestions emanating from any source whatever, and are desirous of obtaining the moral support of everybody interested in the Code, as they feel that this moral support is fully as important as is the financial support. They ask for earnest and sincere cooperation and advice.

In entering upon its activities, the Society held a meeting late in the summer, for organization and a proper division of the work and the voluminous business arranged for. The chairman, Mr. Durban, was authorized to personally visit the legislative representatives and industrial bodies in a number of states, and as a result considerable progress has been made during the early fall months. The chairman made a trip to the Pacific Coast, upon which he was able to meet with the executive committee of the Uniform Law Association in Salt Lake City, the Commission of Public Safety in California, the Commission of Labor in Oregon and the legislative representatives in Washington and Minnesota. Similar activities have been taken up in a large number of the remaining states by other members of the administrative council and definite progress in the matter of moulding public opinion is reported in both the lower Eastern tier of states and in New England.

The states that now recognize the Boiler Code of The American Society of Mechanical Engineers are Wisconsin, Indiana, Ohio, Pennsylvania and California, the last state having but recently established the Code under the authority of the Department of Public Safety. It is also to be noted that the Boiler Code of The Am. Soc. M. E. is in use as the standard code of the Boiler Inspection Department of the cities of Detroit and Chicago. Several other states are undertaking to adapt their boiler inspection departments to the requirements of the Code and some of the boiler insurance companies, notably the Hartford Steam Boiler Inspection and Insurance Company and the Fidelity & Casualty Co., have officially adopted the Boiler Code of The Am. Soc. M. E. as their standard for new boilers throughout all parts of the United States.

In important cooperative movement in the introduction of the Code in the legislative channels in the various states is the recognition given at a recent meeting by the National Electric Light Association, in the approval of the action of The American Uniform Boiler Law Society in its work. This association appointed Mr. John Hunter, member of the Council of The Am. Soc. M. E., as its representative to serve on the administrative council of The American Uniform Boiler Law Society, and it is expected that he will be particularly able in securing the cooperation of member companies in the various states.

An interesting indication of the universal applicability of the Boiler Code is to be seen in its adoption by representatives of the Argentine Republic, as specifications covering all orders recently placed in this country for boilers to be shipped to them. In the specifications of Direccion General Explotacion del Petroleo de Comodoro Rivadavia, 278 Balcarce, Buenos Aires, S. A., the following is stipulated:

Each of the boilers under the items covered by Article I is to have a total heating surface to develop the rated horse power as indicated under Items for each boiler, based upon the evaporation of 34½ lb. of water per h.p., at and from 212 deg. fahr. Boilers will be built for a working pressure of 150 lb. per sq. in. and to general design and in strict conformity with the requirements of The American Society of Mechanical Engineers' Boiler Code, issued 1914.

Similarly, it has recently been reported that the Code has been made acceptable in the city of Manila, P. I., and efforts are being made to bring the matter of adoption of the Code in the entire Archipelago before the Philippine legislature which is soon to meet. The interests of the Code there are being promoted by Mr. Frank L. Strong, of Manila, P. I.

SECOND PAN-AMERICAN SCIENTIFIC CONGRESS

Announcement is made of the Second Pan-American Scientific Congress which will be held in Washington, D. C., December 27, 1915 to January 8, 1916. The headquarters of the meeting will be at the Pan-American Union in Washington, and it will be under the direction of John Barrett, LL.D., secretary general of the Union, and Glen Levin Swiggett, Ph.D., assistant secretary general.

The program of the Congress is divided into nine sections which, with the names of the Chairman in charge, are as follows:

I. Anthropology, William H. Holmes, B.S., Smithsonian Institution, Washington, D. C.

II. Astronomy, Meteorology, and Seismology, Robert S. Woodward, Ph.D., Carnegie Institution, Washington, D. C.

III. Conservation of Natural Resources, Agriculture, Irrigation and Forestry, George M. Rommel, B.S., Bureau of Animal Industry, Department of Agriculture, Washington, D. C.

IV. Education, P. P. Claxton, LL.D., Bureau of Education, Washington, D. C.

V. Engineering, W. H. Bixby, Mem. Am. Soc. M. E., Brig. General U. S. A., Retired, Washington, D. C.

VI. International Law, Public Law, and Jurisprudence, James Brown Scott, A.M., J.U.D., LL.D., Carnegie Endowment for International Peace, Washington, D. C.

VII. Mining and Metallurgy, Economic Geology, and Applied Chemistry, Hennen Jennings, C.E., Washington, D. C.

VIII. Public Health and Medical Science, William C. Gorgas, M.D., Sc.D., Surgeon General U. S. A., Washington, D. C.

IX. Transportation, Commerce, Finance, and Taxation, L. S. Rowe, Ph.D., President, American Academy of Political and Social Science, Philadelphia, Pa.

Some of the Sections are divided further into Sub-Sections. There are forty-five of the latter in all, each with a special committee and program. The deliberations of the Congress will be based according to the subject-matter to be discussed in the various Sub-Sections. There will also be general sessions of the Congress as a whole. The various Sub-Sections of the Congress may arrange for joint sessions. There will also be joint sessions between certain Sections of the Congress and national Associations which may be meeting in Washington at the time of the Congress.

The following persons will be members of the Congress:

a. The official delegates of the countries represented.

b. The representatives of the universities, institutes, societies, and scientific bodies of the countries represented.

c. Such persons in the countries participating in the Congress as may be invited by the Executive Committee, with the approval of the countries represented.

d. All writers of papers.

Upon invitation from the Congress, Dr. John A. Brashear, President Am. Soc. M. E., and Ambrose Swasey, Past President Am. Soc. M. E., have been appointed as delegate and alternate, respectively, to the Congress.

The Committee of this Society coöperating with the Department of State in the conduct of the Congress consists of

Gen. W. H. Bixby, *Chairman*.
Prof. Carl C. Thomas
Charles T. Plunkett
S. W. Stratton
Calvin W. Rice, *Secretary*

All members interested are invited to communicate with the Secretary.

LOCAL SECTIONS CONFERENCE

One of the most important features of the Annual Meeting will be the series of conferences to be held by the Chairman of the fourteen local sections of the Society and delegates from various localities interested in the establishment of sections. The opening session of the conference will take place at noon Tuesday, December 7 and continue throughout the entire afternoon, enabling the delegates to give their individual attention to the matter. The Council has been invited to meet with the delegates at the opening conference in order to give opportunity for exchange of ideas with the representatives of Sections.

The Society considers this conference of great importance to its development and to ensure a full attendance of delegates arrangements have been made to pay the railroad fare of the chairman of each section to the meeting. The policy of the Society is to encourage the members of any locality where there are a sufficient number, to organize a section for conducting professional meetings and developing the Society there. Coöperation will be offered in such cases by granting an appropriation to cover the expenses of conducting

meetings, and assist in securing prominent speakers to address the members. Papers of value before sections will be published in full or in abstract in The Journal.

One fact which is emphasized is that in no case is the establishment of a section in a city where a local engineering society already exists an indication that the Society is entering into competition with that organization. Quite the contrary, the Society wishes in every instance to work hand in hand with the local Society or Club and hold joint meetings whenever possible. However, in practically all centers where local engineering organizations exist, there are a number of Am. Soc. M. E. members who are not members of the local society and therefore not enjoying the benefits of meetings and reunions, and it has been found by experience that the establishment of Sections of the Society in such places not only serves those who belong to the Am. Soc. M. E. only, but also strengthens the local organization and works to the mutual benefit of both groups and the community.

CONFERENCE OF STUDENT BRANCHES

The thirty-eight Student Branches of the Society have been invited to each send a delegate to attend a Conference of Student Branches to be held during the Annual Meeting. They will meet in the rooms of the Society Wednesday afternoon, December 8, from four to six o'clock, to discuss matters of importance in connection with the Student Branch work. The Committee on Student Branches, of which Professor F. R. Hutton is Chairman, will have charge of this meeting. It is expected to have ready for distribution a brochure setting forth the advantages of student membership and the reasons why every student of mechanical engineering should affiliate with the national society. It points out that the student obtains valuable experience in not only conducting meetings but in extemporaneous speaking and in the preparation and presentation of technical papers, and also in numerous other ways. This Conference will, it is hoped, have a stimulating effect on the development of Student Branch activities.

APPLICATIONS FOR MEMBERSHIP

TO BE VOTED FOR ON JANUARY 10, 1916.

Members are requested to scrutinize with care the following list of candidates who have filed applications for membership in the Society. These are sub-divided according to the grades for which their ages would qualify them and not with regard to professional qualifications, i. e., the ages of those under the first heading would place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, while those in the third class are qualified for Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into Membership by advising the Secretary promptly of any one whose eligibility for membership is in any way questioned. All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote. The candidates will be balloted upon by the Council unless objection is received by January 10, 1916.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Barnhurst, Henry G., Mech. Engr., Fuller Engrg. Co., Allentown, Pa.
Bellinger, Daniel L., Ch. Mech. Engr., Finch, Pruyn & Co., Glens Falls, N. Y.
Bent, Stedman, With Phoenix Iron Wks. Co., Meadville, Pa.
Crawford, Chauncey H., Asst. Engr., Mech. Dept., Nashville, Chattanooga & St. Louis Rwy., Nashville, Tenn.
Flowers, Alan E., Prof. of Elec. Engrg., Ohio State Univ., Columbus, O.
Gilbert, Ernest M., Mech. Engr., Wm. P. Bonbright & Co., Inc., New York
Gillespie, William K., Asst. Mech. Engr., Canadian Steel Foundries Ltd., Montreal, Canada
Guthrie, James, Automobile Engr., Briscoe Freres, Jackson, Mich.
Jay, Edward G., Jr., Engr. and Mgr. Meter Dept., Yarnall-Waring Co., Philadelphia, Pa.
Knopp, George W., Asst. Mgr., McClintic-Marshall Construction Co., Pottstown, Pa.
McCoy, Francis N., Master Mech., Hind & Harrison Plush Co., Clark Mills, N. Y.
Manly, Charles M., Vice-Pres. and Ch. Engr., Manly Drive Co., New York
Maxim, Hiram P., Pres., The Maxim Silencer Co., Hartford, Conn.
Means, Edward C., Mgr. Rwy. & Lighting and Pwr. Div., Westinghouse Elec. & Mfg. Co., Denver, Colo.
Rupert, Judson W., Mgr., Virginia Haloid Co., New York
Stephenson, George F., Mgr. and Partner, Earl P. Cooper Co., Wis. Engines, Los Angeles, Cal.
Wood, Horatio N., 1st Lieut. of Engrs., U. S. Coast Guard, U. S. Cutter "Apache," Baltimore, Md.

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Bunge, L. W. A., Mech. Engr., Armour & Co., Chicago, Ill.
Cordes, Paul H., With Internatl. Steam Pump Co., Chicago, Ill.
Dowson, Harry R., Priv. Draftsman for F. W. Matthiessen, La Salle, Ill.
Greene, Harry T., Designing Engr., Aetna Explosives Co., New York
McCleary, Raymond M., Industrial Engr., Kirkman & Son, Brooklyn, N. Y.
Sticht, William, Engrg. Dept., The Singer Mfg. Co., Elizabethport, N. J.

Turner, Robert T., Jr.,
With Foreign Dept., Niles-Bement-Pond Co., New York
Wood, Roland T., in charge of Efficiency Dept., The Standard Tool Co., Cleveland, O.
Zeller, James H., Prod. Engr., American Bronze Co., Berwyn, Pa.

FOR CONSIDERATION AS JUNIOR

Adams, Porter H., Preparing Pocket Book for Aeronautical Engrs., Engineers' Club, Boston, Mass.
Bacon, Howard E., Mech. Engr., Rochester Rwy. & Lt. Co., Rochester, N. Y.
Batten, Loring W., Jr., Instr., Stevens Inst. of Tech., Hoboken, N. J.
Bodine, Alfred V., Mech. Engr., Winchester Repeating Arms Co., New Haven, Conn.
Campbell, Clifford C., Designer Spel. Mchy., Victor Talking Mch. Co., Camden, N. J.
Clark, John W., Asst. Estimating Dept., McIntosh & Seymour, Auburn, N. Y.
Cooke, Stanley S., Student of Production, Remington Arms Union Metallic Cartridge Co., Bridgeport, Conn.
Dilcher, Harry J., Engr. of Tests, Harrisburg Pipe & Pipe Bending Co., Harrisburg, Pa.
Fuhr, Harry E., Student Apprentice, H. W. Johns-Manville Co., Manville, N. J.
Hilbert, Otto W., Student, Mass. Inst. of Tech., Boston, Mass.
Lang, Sidney H., Ch. Insptr., Wheelock, Lovejoy & Co., Cambridge, Mass.
McCune, Joseph C., Mech. Expert, Westinghouse Brake Cos., New York.
Magee, Christopher, Correspondent, Standard Underground Cable Co., Pittsburgh, Pa.
Masferrer, Joaquin R., Stationary Engr., Guanica Centrale, Ensenada, P. R.
Mellen, William H., Heat Treatment of Steel, Springfield, Mass.
Merkt, Theodore B. J., Exper. Engr., Pyrene Mfg. Co., New York
Nordenholt, George F., with Lewiston Bleachery & Dye Wks., Lewiston, Me.
Reed, Edwin W., Efficiency Engr., Reed & Prince Mfg. Co., Worcester, Mass.
Ryder, Earl R., Machinist, Goodman Mfg. Co., Chicago, Ill.
Savage, Leon L., Specl. App., Penn. Lines West of Pittsburgh, Columbus, O.
Severns, William H., Asst. Mech. Engrg. Lab., Purdue Univ., Lafayette, Ind.
Thurston, Arthur L., Inst. in Mech. Engrg., Worcester Poly. Inst., Worcester, Mass.
Walbridge, Arthur H., with Lens Dept., Bausch & Lomb Optical Co., Rochester, N. Y.
Wright, Douglas B., Steam and Chem. Testing Dept., Philadelphia Elec. Co., Philadelphia, Pa.
Young, Joseph E., U. S. Asst. Agri. Engr., Off. of Pub. Roads & Rural Engrg., U. S. Dept. of Agri., Washington, D. C.

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE-MEMBER

Price, William T., Mgr. and Ch. Engr., Pwr. Dept., De La Vergne Mch. Co., New York

PROMOTION FROM JUNIOR

Andrix, Earl R., Asst. Supt. of Pwr., Columbus Rwy. Pwr. & Lt. Co., Columbus, O.
Appleton, Henry W., 243 Van Houten Ave., Passaic, N. J.
Benner, Henry L., Secy. and Treas., Amer. Insulating Mchy. Co., Philadelphia, Pa.
Davey, Warren, Ch. Engr., Colgate & Co., Jersey City, N. J.
Dent, John A., Assoc. in Mech. Engrg., Univ. of Ill., Urbana, Ill.
Haglund, Gustav, Designer, Public Service Elec. Co., Newark, N. J.
Johnson, Harry D., Jr., Ch. Plant Engr., Studebaker Corp., So. Bend, Ind.
Lewis, Arthur S., Eastern Rep. and Trav. Mech. Engr., Chicago-Cleveland Car Roofing Co., New York
Loudon, Andrew C., Mech. Dept., Editor, Rwy. Age Gazette, New York
Peel, Fred P., Pres., Southern Sales Co., Washington, D. C.
Phelps, Charles C., Publicity Dept., Ingersoll-Rand Co., New York
Treat, Sidney W., Off. Mgr., The Schickel Motor Co., Stamford, Conn.
Van Deinse, A. F., Genl. Mgr., Springfield Gas & Elec. Co., Springfield, Mo.
Yates, Richard L., With Platt Iron Wks., Dayton, Ohio

SUMMARY

New applications	51
Applications for change of grading:	
Promotion from Associate-Member	1
Promotion form Junior	14
Total	66

MOTION STUDY FOR THE CRIPPLED SOLDIER

BY FRANK B. GILBRETH, PROVIDENCE, R. I.,

Member of the Society

TO-DAY there are two million men living in Europe who have suffered the loss of limbs, faculties, or both, as a result of injuries in the great war. Before this war is over this number will be enormously increased. No one who has not actually seen hundreds of wounded soldiers writhing in agony in the cars or hospitals can fully realize the conditions that exist, but the pictures and accounts from the front have been so vivid that the whole world has been aroused to a concrete expression of sympathy and efforts to alleviate the immediate suffering.

However, there has been, as yet, little or no thought given to the permanent suffering that is by far the most serious aspect of the subject. What is to be done with these millions of cripples, when their injuries have been remedied as far as possible, and when they are obliged to become again a part of the working community? At the close of the war the various countries now engaged in it will find themselves for years, and probably decades, fully occupied in devising ways and means for paying the interest on their enormous debts. They will not be able to pension adequately and properly to provide financially for their astounding numbers of incapacitated soldiers. Neither would any system of pensioning, if that were financially possible, completely solve the problem, since the large majority of such cripples will be helped more by being provided with interest and occupation as well as financial support. The great problem that faces the world to-day is, therefore, immediate and permanent provision for enabling these millions of crippled soldiers to become self-supporting. This is a world problem rather than a problem for those countries only that are directly involved in the war, and demands a world-wide solution.

Mr. Gilbreth has spent considerable time in Europe systematizing industrial plants and has been deeply impressed by the vast numbers of wounded and crippled soldiers who will find it difficult to obtain employment after the war. He proposes motion studies of various lines of industrial work, and similar investigations of the maimed soldiers, to determine what lines of work are open to the various types of cripples, as a means for providing employment and occupation for these unfortunate men.

The crippled soldiers are of many types, for this war is a war of all classes, and not of the professional soldiers only, as one is at times inclined to think. In all countries, men from the colleges, the professions, the shops and the factories are at the front along with the usual military force. The cripples, therefore, will be of all types, and vary in training and capability as well as in the injuries that they receive. We might, therefore, roughly classify them as follows:

a Men who have done chiefly mental work.

b Men who have done chiefly physical work, but whose capabilities will allow them to be transferred to mental work.

c Men who have done physical work, and whose capabilities and inclinations are confined to physical work.

The first two classes can be handled with comparative ease when crippled. The third class presents the most difficult phase of the problem. This problem might be summarized as that of teaching and fitting cripples for some sort of productive work, and specially modifying and adapting the work to the individual capabilities, preferences, difficulties and shortcomings. The problem is an exaggerated new form of vocational guidance, vocational training, and systematic placement of men.

The educators have been quick to see their responsibilities in this work. They have provided, wherever possible, in existing or new institutions, opportunities for crippled brain workers to become productive, and have been ready and willing to devise opportunities and to furnish teaching for those previously engaged in physical work to learn and to use any mental work of which they are capable. They have, however, realized with equal rapidity their limitations in placing crippled soldiers whose bent is towards some type of physical work, as they have seen that this line of placement lies in the specialized field of the management engineer.

The engineer, both because of his training and practice, thinks largely in terms of physical capacity and its concrete results. The engineer of to-day emphasizes the human element as a factor in accomplishing results, and it is his peculiar province to make this human element most efficient. Knowing that the author had specialized for years in this type of work, educators in the various warring countries have urged him to attack this particular branch of the crippled soldiers' problem, and to put the results of modern management in general, and of motion study in particular, at the disposal of those in active charge of training the cripples. No great amount of urging was needed. The author has, since the war began, crossed more than a dozen European frontiers. He has visited many hospitals and recovery homes, and seen at first hand the frightful need, and he returns to this country not only with the desire to be of service, but with a definite plan as to how service can be most adequately rendered.

The method of attack of the problem is as follows: It is realized that the psychological feature is an important one. A prime necessity is to inspire the cripple with the feeling that he can remain, or become, a productive member of the community. This is done by gathering data as to cripples of various types who have succeeded in becoming useful and earning members of the community. These data consist of

Presented at a meeting of the New York local section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, October 12, 1915.

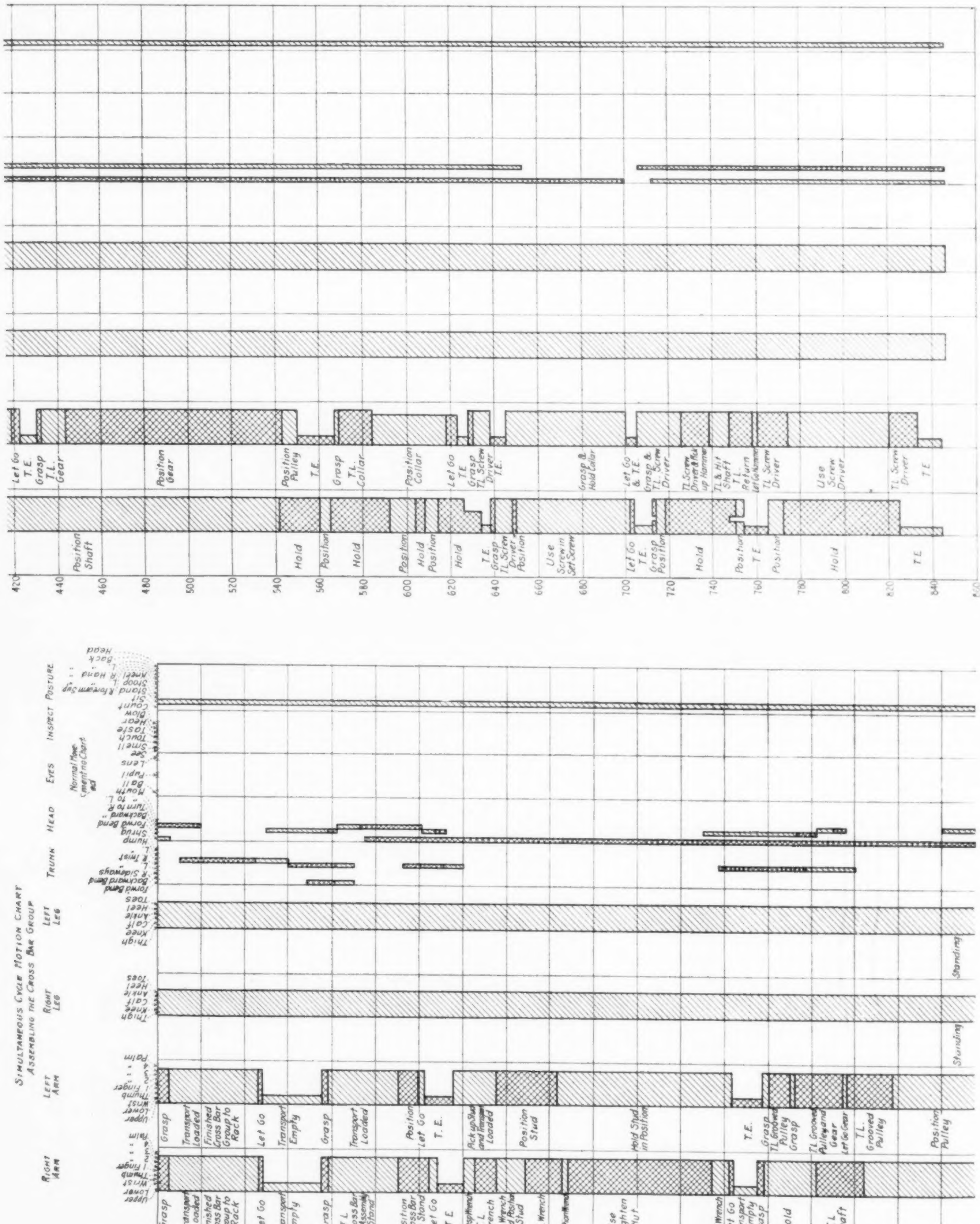

FIG. 1 CHART UTILIZED FOR VISUALIZING MOTIONS USED OR NECESSARY

concrete examples of men, women, or children incapacitated in any way, who have been enabled by any possible means to be useful to themselves and to society. Such data have been and are being accumulated at an astonishing rate. They serve not only to encourage the cripple by suggesting that what has been done, can be done, but also by indicating immediate methods of attack upon individual problems. Back of all these individual illustrations, however, must lie a scientific method for attacking the general and the individual condition of each cripple, for diagnosing the particular case, and prescribing an adequate remedy. This is our contribution towards the solution of the problem.

The motion study method of attack considers the work to be done as a *demand* for certain motions, and the proposed worker as a *supply* of certain motions. It aims

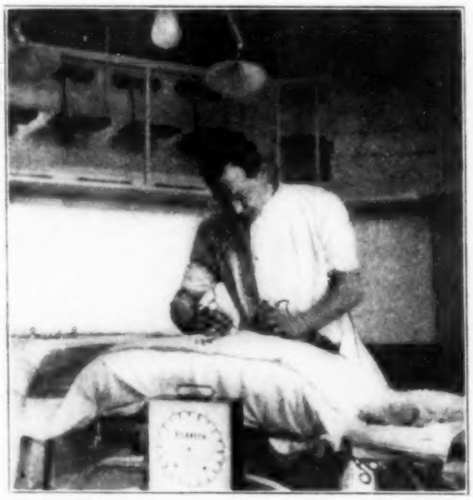

FIG. 2 ATTACHMENT OF ELECTRIC BULBS TO HANDS OF SURGEON FOR MAKING CHRONOCYCLEGRAPH OF SURGICAL OPERATION

a To consider all work from the motion study standpoint,—to discover exactly,
 1 What motions *have* been used for the work.
 2 What motions *may* be used for the work.
 3 What motions *must* be used for the work.

b To discover what motions are possible to the proposed worker.

c To determine which type of work may best be adapted to the worker, and how.

It may be well to state that motion study considers always three groups of variables, which, in the industries, are

a The variables of the worker.

b The variables of the surroundings, equipment and tools.

c The variables of the motions.

In adapting motion study to the crippled soldiers' problem, we are considering these same three groups.

We realize that our problem is twofold in its aspect. It consists of

a Determining the type of work that the particular worker can best do.

b Determining that method by which he can best be taught to do the work.

The teaching element is more important in this new phase of adequate placement than it has ever been before, because in every case a new or changed worker must be made useful, self-supporting and interested. That he become and remain interested implies the highest form of teaching and of learning.

The first step in adequate placement through motion study lies in visualizing the motions used, or necessary, in any given type of work. The simultaneous cycle motion chart is a device for recording and showing the interrelation of the individual motions and cycles of motions used in any method of performing any piece of work. This motion chart was devised and is used by us in our consulting work of motion study in the industries. Here we deal mostly with those who have the use of all their limbs and faculties, but the chart is equally applicable when dealing with cripples.

The elements of a cycle of decisions and motions, either running partly or wholly concurrently with other elements in the same or other cycles, consist of the following, arranged in varying sequences: 1. Search, 2. Find, 3. Select, 4. Grasp, 5. Position, 6. Assemble, 7. Use, 8. Dissemble, or

FIG. 3 CHRONOCYCLEGRAPH OF A COMPOSITOR PUTTING TYPE IN A STICK

take apart, 9. Inspect, 10. Transport, loaded, 11. Pre-position for next operation, 12. Release load, 13. Transport, empty, 14. Wait (unavoidable delay), 15. Wait (avoidable delay), 16. Rest (for overcoming fatigue).

The simultaneous cycle motion chart is best made on decimal cross-sectioned paper. The horizontal lines, reading from the top down, represent time. We have found that the thousandth of a minute is the best unit with which to work. The various vertical spaces are divided into anatomical groups, such as right arm and left arm, consisting of the subgroups, upper arm, lower arm, wrist, thumb, first finger, second finger, third, fourth, and palm; right leg and left leg, with the subgroups of thigh, knee, calf, ankle, heel and toes; trunk, with the subgroups of forward bend, backward bend, bend to right, bend to left, twist to right, twist to left, hump, and shrug; head, with the subgroups of forward bend, backward bend, turn to the right, turn to the left, and mouth; eyes, with the subgroups of ball, pupil and lens. There should also be the general heading of *inspection*, with the subdivisions of see, smell, touch, taste, hear, blow, and count; and the heading *posture* with the subdivisions of sit, stand, kneel, stoop, right forearm supported, left forearm supported, right hand supported, left hand supported, back supported and head supported, etc.

Charting the data in this manner makes it possible at a

glance to visualize a simultaneous cycle and the elements of the cycle of work done. The various motion cycles in the method under investigation are analyzed into these elements. Through this analysis we are able to work out new sequences, cycles and methods of doing any type of work. Thus many types of work that have been formerly considered possible only for the man in complete possession of all his members and faculties can be adapted to the maimed or crippled worker. The chart shows in a concrete form which members and faculties of the associated units or working members of the human body are doing the work, are inefficiently occupied, or are available for doing parts or all of the work. They enable us to see at a glance not only how motions are at the present being made, but the possibilities of shifting these motions to other members of the worker's body. In other words, when using these charts for the crippled soldiers' work we are enabled to proceed immediately and directly to the more efficient rearrangement, distribution and assignment of the necessary motions to the different remaining members.

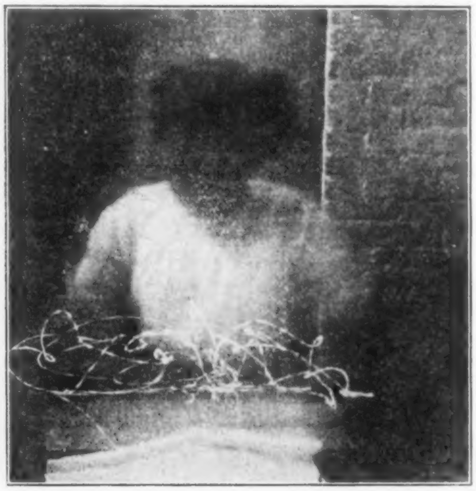

FIG. 4 CHRONOCYCLEGRAPH OF THE TWO HANDS OF A GIRL FOLDING HANDKERCHIEFS

The data included in these charts are gathered through various methods of making motion studies, especially by the use of the micromotion method and the chronocyclegraph method of recording motion in the research laboratory. Here records of methods are made with the special devices, microchronometer and the cinematograph, and also with the chronocyclegraph apparatus. The former type of records record the activity of the worker, the surroundings, equipment and tools, and also the time of the motions used. The latter records show the directions, speeds and paths of the motions. The records serve not only as data for the simultaneous cycle motion chart, but also as the most efficient of teaching devices. From the chronocyclegraph records are made motion models that not only make it possible for teacher and learner to visualize the desired motions from all viewpoints, but that also serve as path guides in case the worker taught is of the motor type.

Until recently, it has been considered good enough practice in the industries to teach the traditional or existing method of a successful workman. Through the methods and measuring devices of precision used in the motion study laboratory we are now able to record with exactness and in detail the methods of the most skilled workmen. By the use of the scientific method of analysis, measurement and synthesis we arrive at the method of least waste for performing the work. Through special teaching devices we then transfer the selected elements of skill and experience, in a new synthesized cycle of least waste, to workers who have never had that all around, non-guided experience or its slowly acquired skill. Not only are the methods transferred more efficiently but there is saving of time and effort to both teacher and learner, as is satisfactorily shown by learning curves of many past performances on widely varied types of work. The teaching devices, which we have specially adapted to appeal to as many types of workers as possible and to all available senses, are especially useful with crippled learners, where it is often necessary to specialize on some particular sense training.

The fatigue study that accompanies the motion study provides for the elimination of all unnecessary fatigue, and for adequate rest for overcoming necessary fatigue. Such study is imperative in the work with cripples, since the greatest of care must be taken that the maimed worker is not overtaxed.[1]

While this method of attack is bringing gratifying results, no great headway can be made with the crippled soldiers' problem without worldwide coöperation. Such coöperation has been forthcoming wherever interest in the subject has been aroused. We gratefully acknowledge the receipt of suggestions and coöperation from members of our organization, from friends in many parts of America and other countries, and particularly from the alumni and friends of our Summer School of Scientific Management, and we most earnestly beg for more and more. We need photographs, records and histories of cases where cripples have been made comfortable and less fatigued in their work, and have been taught and are successfully doing work in spite of their apparently insurmountable handicaps. The crippling is of every conceivable type, and every success will encourage some disheartened invalid to take up life with a new courage. We want also suggestions for adaptations of machines, tools, and other equipment or surroundings to workers. For example, we have found that typewriter manufacturers have made attachments for the use of operators having one hand only. We have seen such an operator handle the modified machine with satisfactory results. We have found that slight modification of other machines permits assigning their operating and controlling parts to the remaining limbs of the workers, and thus makes possible their successful handling by injured operators. Any kind of an adjustment

FIG. 5 DIAGRAM OF THE MOTIONS OF A GIRL FOLDING HANDKERCHIEFS AND A WIRE MODEL MADE FROM IT

[1] See "Fatigue Study," Sturgis and Walton.

or adaptation may be not only useful in its particular field, but may also form a missing link in an invention in an entirely different field. We will gladly take all data sent us and make them immediately useful to those working on the training of the injured soldiers in all countries. We have found it most efficient to think of all activity in terms of motions and decisions. Through more than thirty years of work in motion study we have facilities that make it possible to analyze all data into terms of motion economy, and thus to make them useful with the least waste in transmission or handling time.

This work of helping the crippled soldiers by teaching them to make the most of their motion possibilities should be the special contribution of the engineer in the field of social betterment. The opportunities for such work to-day are especially large because of the great war, but the methods that we now advise and use because of the great pressure will be available at all times. Through the reclamation service, if we may so call it, that we are using for the war cripples to-day, we are introducing a method that will never become unavailable or unnecessary.

We beg every member of the American Society of Mechanical Engineers to coöperate in this work, with us and with our friends abroad, who are waiting to pass on the data to those who need it so sorely. It is a work that is both timely and permanent. The need is sudden and new, but the data will be useful forever.

DISCUSSION

L. M. Wallace (written): It is indeed gratifying that such an able investigator as Mr. Gilbreth has consented to devote time and effort toward solving the problem of providing for the instruction of those disabled by the European war. That large numbers of young men of the highest type are being crippled for life is indeed as distressing as that so many are losing their lives in this great world calamity. It is my conviction that it is just as noble an undertaking to attempt to provide suitable means of preparing the disabled for useful vocations as it is to attempt to stop the terrible conflict or to provide means of first aid. Indeed, it is a greater thing than many realize, because it will mean untold benefit to thousands now deprived of those avenues of activity to which they have been accustomed. It will mean the fitting for useful vocations of thousands, who otherwise would be dependents upon society, which is always a greater burden to the one so afflicted than to those of society who bear the expense of such disability. I therefore hope Mr. Gilbreth and his associates may achieve much and that the members of this Society will rally to his support by extending encouragement, helpful suggestions and material assistance in the form of thought, labor, and money, if desired.

Edward Van Winkle: There is no question but what the adoption of a machine to a crippled soldier or a man without arms or legs is the duty of the mechanical engineer. I remember seeing the driver of a speed car, a man without arms, travel over a hundred miles an hour in a machine especially designed for him. The steering gear of the machine was adapted with shoulder yokes and the rest of the apparatus was operated by his feet. I saw him go from high speed forward to high speed backward inside of 50 ft., and he had a record of 108 miles an hour. There is no doubt that there are a number of instances of that kind in which with special machines cripples have been enabled to emulate those with full faculties.

W. Herman Greul inquired whether Mr. Gilbreth had outlined any standard method of reporting these instances

Fig. 6 Examples of Application of Cinematograph to Motion Studies of Workmen

which he could use in his tabulations. He wondered whether he had already tabulated the information which he desired, which would be very helpful in aiding the members to contribute.

Dr. Yeager, in his discussion, said, as a physician, he had been interested in cripples for a good many years, and in the course of his work he saw the necessity for providing

means of occupation for many of these cripples. Some three years ago he opened a school for the training of men who had been maimed or injured or who, through some disease, were incapacitated from active work. In this school as patients were men sixteen up to thirty-five, who were taught reed work of all kinds, reed furniture making, rush seating and basket making. To the men who have the use of one and one-half hands, and whose minds are sufficiently developed, mechanical drawing is taught. For the men with one hand only, we selected glass mosaic work; a plan was devised for holding the glass so that with the one hand the worker could take his glass cutter, cut the piece of glass and fit it into the pattern he was making. We have taught show card writing, and also silversmithing.

As you will notice, most of these trades are for men who have the use of two good hands. Reed work needs two good hands. An encouraging feature of this work is that men who had never done any of this kind of work before, men who had never done any skilled work with their hands at all, would, in the very shortest space of time, become expert. I remember one young man, a structural iron worker, had an injury in which he lost one leg. He had no other trade, but he came to the school and became an expert silversmith; he did very beautiful work. He developed into a very fine draftsman, although he had no home training. He was a man from the very lowest circles, but the surroundings, the beautiful designs that we gave him, developed in him a desire for creating beautiful things, and he became a very skilled craftsman.

Another case was that of a young man who was born with his hands in an abnormal position, rendering them practically useless. We taught him show card writing. He held his pencil in his left hand, and he was able to draw and make letters very well. Another young man, whose right hand was paralyzed, just had sufficient power to hold his paper and pen, to do mechanical drawing.

A man who had paralysis in both legs, and who needed two crutches, as both his legs dangled under him in a very unseemly fashion, learned the trade of chair caning, and during the summer vacation he managed to get the contract for a large club which needed several hundred chairs, and this cripple engaged ten able bodied men to work for him.

A boy with a very bad deformity of the hip needed two crutches to go about the workshop, but notwithstanding this he was able to work very well.

The work at this school is being done in the City of New York. It is the only school of its kind in the country, and whereas we have not attempted to get the men into work where machinery is required, we feel that we are filling a definite place in the work that we have done.

MR. HANAU: When radium was discovered it was thought to be good for anything, for everything, for tuberculosis, for cancer, and for almost everything. The same remark applies to moving pictures. If you consider the moving picture, however, you must always keep in mind that it is a perspective. In the second place, you must keep in mind that the movements are not all in plane, so that they are very deceiving. To represent the three dimensions by photographs, you have to take them from the three sides, that is, the front, side and back projections. Then you can combine a movement which will be followed up very accurately. While this method is very good for efficiency, I do not think it is of very much value for just the purpose of this paper.

In working out data for members and other parts of the body for crippled soldiers, or maimed persons, one must be very careful. Such data cannot be represented only by a perspective picture, although perspective pictures are very valuable in shop practice.

F. ZUR NEDDEN: A few weeks ago Mr. Gilbreth showed me a novel improvement of his method, giving the means for taking motion studies in the tri-dimensional way. For this purpose, Mr. Gilbreth first photographs a tri-dimensional net of white lights, he then removes the net, places the workman in position, and makes motion studies. By this

FIG. 7 CYCLEGRAPH OF A MAN OPERATING A MACHINE WITH WHICH HE IS NOT FAMILIAR

FIG. 8 CHARACTERISTIC ORBIT OF THE SAME MAN AFTER MAKING A HALF DOZEN PIECES ON THE MACHINE

FIG. 9 CYCLEGRAPH OF SAME MACHINE AFTER IMPROVEMENTS MADE TO FACILITATE HANDLING OF MATERIAL

way he can conceive, especially if he makes photographs stereoptically, exactly the place every motion in space occurs. This would meet the objection raised by Mr. Hanau.

H. E. Resseler gave an instance of a mechanical device made recently in one of our hospitals in New York City. A young girl had a form of tetanus and by removing the muscles of the lower jawbone, and making a device with a spring, to be wound up just like one would wind up a clock, fastening it to the jaw and running it over the head, the jaw was kept in constant motion. After about three weeks the device was taken off. It was surprising to note how the muscles of the inferior maxillary had developed. The girl was then put to chewing gum, and the development of the muscles of the lower jawbone was continued.

James Gibbons: The work proposed to be carried out in Europe with a view to aiding crippled soldiers should hold a very important lesson for us in this country, because it seems it is an attempt to approach the efficiency question from another point of view than that which we are accustomed to. There is a tendency I think on the part of the efficiency engineer to pay more attention to the man of efficiency and to a certain extent discard the less efficient man, and a good deal of the opposition to efficiency methods which no doubt exists in the minds of many, and especially of workmen, is due to the feeling that the men naturally less efficient will be sacrificed to a great extent to those more efficient.

The fortunes of Europe are forcing upon men the necessity of taking care of their less efficient fellows.

From the point of view of the working public and from the point of the good of the country as a whole, this is perhaps the real foundation on which we should build on efficiency efforts—from the bottom up rather than from the top down; and I think we would be making a great mistake if with our own prosperity and our own good fortune in this country we should not give our careful attention to what is being done in Europe and watch carefully for the results which will come from this effort to raise the efficiency of those who are naturally inefficient.

W. N. Polakov: The paper by Mr. Gilbreth is of great importance, not only for the European problem of the near future, but for that in the United States, which is, so to speak, permanent, because industrial accidents happen and will happen in this country, although probably in diminishing proportion. It is well known to us how much money is being paid to the crippled soldiers of former wars, although if provision of some kind had been made in this country they could have been put to productive work and not be a burden on the country, but be productive members of society; but aside from that there was a question raised here whether it is in the domain of an engineer to look into this matter. In my opinion, it is most emphatically so, and I think we all owe Mr. Gilbreth thanks that he raised this question in our own Society.

The case of the crippled soldier is nothing but using the triple expansion human body as a compound, or something less than that, as it were, and therefore it is a problem of engineering, and of the works manager to adapt these conditions, or the men to the conditions, so that they will be useful. It is not so much the question of the selection of the man for the particular work, as the adaptation of the available man to the work which is to be done, whether the man is crippled or not.

As to the instruments devised by Mr. Gilbreth, I have watched and studied them in actual use, in the New England Butt Co.'s laboratory, although the details were too complicated to be explained in a short talk. The point of importance is that the motion shall be studied in order to save the waste motions and find out in what industrial processes certain limbs and certain parts of the body, certain muscles, are used.

In a factory where wearing apparel is sewn, the legs are absolutely unnecessary, as the machines are driven by a motor. In many other industries, when we consider it necessary to employ able-bodied men, we are doing a great injustice to those who are crippled, and more than that, we manifest our own lack of understanding. We do not want legs for the man who is working with his brains, and vice versa for the messenger boy it is not necessary for him to have two hands. For a telegraph operator two arms or two hands are entirely unnecessary, and many other examples could be cited.

Alwin Louis Schaller: I think that one of the points ought to be emphasized that Mr. Gilbreth brought out in his paper, and that is the psychic state in which the man must be brought before he can be made successful. The only reason why a cripple is so successful is because he has a will and a determination to devise his own methods for doing things.

I believe that one of the largest problems that Mr. Gilbreth had to confront when he began to reclaim these crippled soldiers was to get them into a state of mind where they could forget the discouragements into which they had probably fallen after receiving their wounds and realizing that they would have to go through life in a crippled condition.

Robert Thurston Kent, who presented the paper, said: Last August I spent a day at Mr. Gilbreth's laboratory and saw what he had developed in the four years since I was associated with him, and Mr. Gilbreth converted me to a number of things that I believed were absolutely impossible two or three years ago, and I would suggest that all who are skeptical as to the value of the moving pictures of stereoscopic photographs and the three dimensions visit Mr. Gilbreth's laboratory, where they will learn a great deal.

The problem of efficiency or scientific management is to point out the job at which a man is a first-class man and put him in it.

Mr. Gilbreth has a standard method of tabulating. He lays out a chart divided into different groups, as explained in his paper—the head group, the different arm groups, etc., subdividing them into the forearm, the hand, thumb, and so on. By means of his photographs he finds out the relevant amount of time each member of the body is employed on a given job; he plots them on a vertical scale as to time. Striking a curve through these ordinates, he can see the relative importance of each particular member of the body in doing certain work.

The particular method employed is to take these charts and see if these motions of all the parts cannot be eliminated altogether, so that in the case of only a right hand motion, the motion of the left hand is gotten rid of, making it all a job on which the right hand only is employed.

GAS VOLUME AND DUST CONCENTRATION DETERMINATION IN CONNECTION WITH THE COTTRELL PROCESS

WM. N. DREW, LOS ANGELES, CAL.

Member of the Society

It is evident that, for general engineering work, any apparatus for determining the velocity of the gases in the conduits of a plant to which a Cottrell treater is to be applied must be portable, accurate, simple in construction, and easily and readily manipulated. Anemometers are unreliable in a fluctuating flow, otherwise they comply with all the above requirements; they are necessarily somewhat delicate, and in hot, dusty gases their mechanism may be seriously deranged. Venturi tubes are easily manipulated and very accurate, but are not portable. The Thomas electric meter is extremely accurate, but it also is not portable.

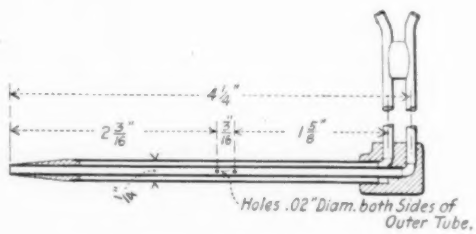

FIG. 1 TYPE OF PITOT TUBE USED

The Pitot tube is the last choice and fulfills very completely all the stated requirements, while in addition it is inexpensive and easily constructed. This instrument is a well-known one, and tests of particular types have been the subject of extensive investigations. It is estimated that, with the type of Pitot tube illustrated in Fig. 1, which is the standard testing tube of the American Blower Company, and with accurate gages, it is possible to obtain an accuracy of within 1 per cent. However, even with an absolutely accurate tube, uncontrollable conditions in the gas flow may vary results a like amount.

The Pitot tube follows the law of falling bodies, and a working formula based on this may be derived as follows:

where

- T = absolute temperature of flowing gas in deg. fahr.
- K = absolute temperature of flowing gas in deg. cent.
- P = absolute pressure of flowing gas in lb. per sq. in.
- B = absolute pressure of flowing gas in inches of mercury
- d = weight per cu. ft. of flowing gas at a given temperature and pressure
- G = specific gravity of flowing gas (air = 1.0)
- V = actual velocity of flowing gas in ft. per sec.
- h_f = height in ft. of a homogeneous column of gas at given temperature and pressure producing V
- h = corresponding height of water column in in.
- d_w = weight per cu. ft. of water = 62.37 lb. at 60 deg. fahr.
- d_a = weight per cu. ft. of air at 32 deg. fahr. and 14.7 lb. = 0.08073 lb.
- g = acceleration due to gravity, taken as 32.16

$$V = \sqrt{h_f}$$

$$= \sqrt{\frac{2ghd_w}{12d}}$$

since $dh_f = \frac{hd_w}{12}$ and $d = d_a G \frac{P}{14.7} \times \frac{491.2}{T}$

hence

$$V = 11.12\sqrt{\frac{hT}{PG}} \quad \ldots\ldots (1)$$

$$= 15.88\sqrt{\frac{hT}{BG}} \quad \ldots\ldots (2)$$

$$= 21.30\sqrt{\frac{hK}{BG}} \quad \ldots\ldots (3)$$

For air G = 1 and at atmospheric pressure B = 29.92, so (3) becomes

$$V = 3.894\sqrt{hK} \quad \ldots\ldots (4)$$

Within the errors of observation, these formulae are accurate for dry air up to 100 ft. per sec., but at 183 ft. per sec. they give results 6 per cent too high and at 383 ft. per sec. 15 per cent too high.

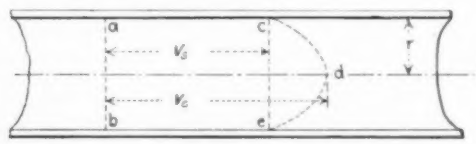

FIG. 2 PARABOLIC FORM OF CURVE EXPRESSING THE VELOCITY IN CROSS-SECTION OF CONDUIT

The location of the Pitot tube in the conduit is a matter of considerable importance, especially as it is usually desired to obtain the average velocity for a given cross section. The law governing the variation of velocity from center to side of a conduit has not been definitely established, and, moreover, the determination of the velocity contour is difficult owing to errors of observation, abnormalities of flow and to the impossibility of making a measurement at the extreme edge of the pipe.

If we assume that the curve expressing the velocity at a cross section is a parabola with its vertex at the axis of the pipe, we may deduce a relation between the center velocity V_c and the mean velocity V_m in a cylindrical conduit of circular cross section as shown in Fig. 2. From this diagram it may be seen that the amount of fluid passing the section each second is represented by the solid generated by rotating the figure *acdeb* about *fd* as an axis. The volume of this may be divided into two parts, one a cylinder *aceb* and the other a paraboloid *cde*. The volume of the cylinder is $\pi r^2 V_s$ and of the paraboloid $\frac{1}{2} \pi r^2 (V_c - V_s)$. If we divide the total volume of the solid by the area of the pipe we obtain $V_m = \frac{2\pi r^2 V_s + \pi r^2 (V_c - V_s)}{2\pi r^2} = \frac{V_s + V_c}{2}$

If we assume that the surface velocity is one half that at the center, we may write $V_m = 0.75 V_c$.

Similarly on the assumption that the contour is repre-

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sented by an ellipse, since the volume of an ellipsoid is two-thirds that of the circumscribed cylinder, we may write

$$V_m = 3\pi r^2 V_s + 2\pi r^2 \frac{(V_c - V_s)}{3\pi r^2} \text{ and on}$$

assumption that $V_c = 2V_s$, $V_m = 0.83\ V_c$

Although it is apparent that an approximate relation exists between the mean and maximum velocities in a conduit of circular section, too much dependence must not be placed on this ratio. Loeb (Journal A. S. Nav. Eng., vol. 24, p. 1115, 1912) states that a single Pitot tube at the center of a circular duct will have a coefficient of mean velocity of 0.91 to 0.94, depending on the size of the duct and the velocity of the air. For a 12 in. galvanized iron pipe, Rowse found that results within 2 per cent may be obtained by using the ratio 0.895.

This regular flow is disturbed by expansion, contraction, or curvature of the conduit, and more especially by obstructions. It is probable that in a gas stream, as in a water stream, the static pressure after expansion or contraction will be higher than the normal, and that after a curve the indications of pressure on the concave side will be high and on the convex side low. Rowse found that gas flowed through a pipe with a wave or spiral motion even when many screens were inserted to straighten out the stream lines. Curves obtained by traversing the cross section of pipes with the Pitot tube show more or less uniformity.

Rowse states that in gas measurements a Pitot tube station should be preceded by a length of pipe 20 to 38 times the pipe diameter. Fan discharge into a pipe line disturbs the flow somewhat, but Treat (Trans. A.S.M.E., vol. 34, p. 1019, 1912) states that good Pitot tube measurements can be taken 8 to 12 diameters away from the fan.

Since there are so many unknown conditions in a conduit conveying gases, it is evident that the most reliable results will be obtained by making a large number of measurements in the particular cross section selected. In a circular duct, the cross section may be divided into a number of annular rings each having the same area, and then, by taking readings at equal intervals around these rings, velocity readings can be obtained and readily averaged. In averaging these readings, the mean of their square roots must be used rather than their direct arithmetical mean.

Traverses in a pipe along one diameter only are not sufficient, as readings on vertical and horizontal diameters are rarely the same, except at the points nearest the center. For a conduit of any section, a more accurate method is to make these traverses along several diameters, and then, after making a contour for each diameter, combine these into one which will show the contour for the entire cross section. Fig. 3 shows a contour obtained in this way. Twelve readings were made on each of the four diameters by a movable Pitot tube, another Pitot tube being kept fixed in position at the center of the cross section and readings being taken simultaneously with the movable tube. The velocity readings obtained with the fixed tube were averaged and this velocity used as a base from which to correct the velocities obtained with the movable tube, since all the velocities in the cross section are continually varying; it was assumed that the other velocities varied according to the ratio between the average center velocity and the "instantaneous" center velocity, and this ratio was applied as a correction. With a planimeter, the area shown on the final contour plot corresponding to each velocity was measured, and from this a weighted mean was calculated for the entire cross section. In this particular case the mean velocity was 64 ft. per sec.; and it is interesting to note that the region of maximum velocity was not at the center. The cross section shown is in a stack carrying gases from a cement kiln, and is 100 ft., or about 20 diameters, from the mouth of the kiln. In the stack base, the kiln gases are first deflected downwards by a

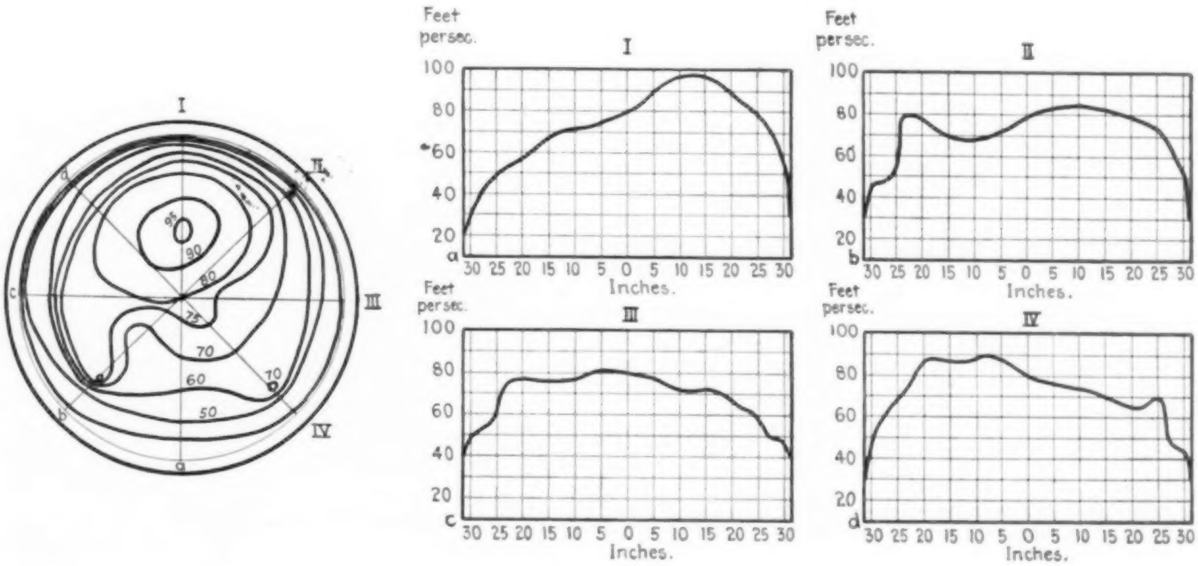

FIG. 3 RESULTS FROM TRAVERSE READINGS WITH MOVABLE PITOT TUBE ACROSS DIFFERENT DIAMETERS OF CONDUIT

curtain wall, and on resuming their general upward travel their motion acquires a horizontal component in "reaching out" for the stack entrance, and the gas volume "hugs" the stack all the way to the cross-section shown.

After several such determinations as this, a ratio between the mean velocity and the velocity at any other point can be determined; and by using this ratio one measurement will indicate the total gas volume. In choosing such a point, it is obvious that the location should be such that no rapid

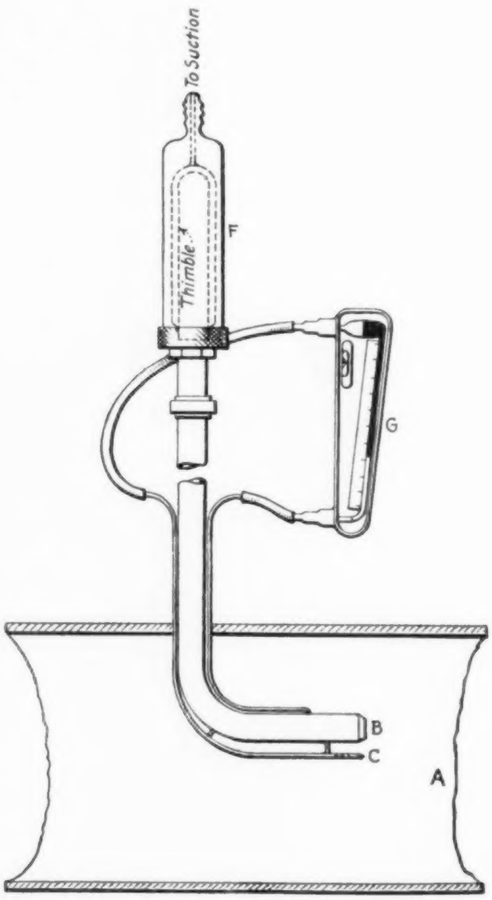

FIG. 4 DETAILS OF APPARATUS USED FOR ENTRAPPING KNOWN VOLUME OF DUST-LADEN GAS

changes in velocity are occurring. This point is near the region of highest velocity rather than at the point of average velocity.

DUST DETERMINATION

After the gas volume to be delivered to the treater has been determined and the treater built and placed in commission, the question arises: How much of the suspended matter is the treater collecting? This is a natural question from the engineer's standpoint, for he always wants to know the efficiency of his apparatus, and also from the client's standpoint, for it behooves him to know whether or not any valuable material is being lost. Also, it may happen to be a natural question from the legal standpoint, for it might be necessary to know if any regulations regarding emission of fumes are being violated.

Aside from the question of the amount of the escaping material, it is desirable to know its composition, so that the percentage loss of valuable material may be calculated. In order that all these questions may be determined, it is necessary to remove some of the gas with its accompanying dust. The ideal way to do this would be to entrap a known volume of the dust-laden gas, weigh and analyze the solid matter carried by it, and from these data calculate the ratio desired.

Fig. 4 shows diagrammatically an apparatus which is used in an attempt to approximate this ideal method. *A* is a conduit through which the gases and dust are passing. In this conduit is placed a tube *B*, with its mouth pointing toward the flow of the gases, and, at the other end of this tube, suction is applied to draw through some of the gas with its accompanying dust.

As the gas passes through the pipe it reaches the filter *F*, which retains the solid matter but allows the gas to pass. This filter consists essentially of two parts, a Soxhlet fat extraction thimble, and a holder of brass hollowed to receive the thimble. The essential features of this holder are a tight fit at the mouth when the knurled nut is screwed home, and a good clearance, say about 1/8 in., around all sides of the thimble. The reason for this first essential is obvious, for leakage must be prevented, while the second one is indicated by experience, tests having shown that the filter quickly clogs if there is only a slight space between the thimble and the holder.

In order that a fair sample of the gas and dust may be obtained, the suction applied should be such that the velocity at the mouth of tube is the same as the velocity in the stack, for, if it is greater, more dust is drawn through in a given time than should be, and vice versa. To adjust the velocity in *B*, two static tubes are used, one of which, *C*, is a closed tube with small holes near its tip, the other is a tube drawn down to a small hole and opening to the inside surface of *B* near its mouth. The other ends of these tubes are connected to a balancing gauge, *G*, and the suction adjusted so that the column is always in balance.

After suction has been applied for a known length of time the filter is removed, dried, and weighed; then from the amount of dust in the filter, the time of aspiration, and the ratio of the area of *B* to the area of the conduit, the amount of dust passing through the conduit *A* in a unit of time is calculated.

An important feature of the operation of this and other apparatus using a filter is the proper previous and subsequent drying of the filter thimble. The amount of dust caught is usually so small that an appreciable error is introduced if moisture is present in the thimble. The thimble should be dried at about 100 deg. cent. for two hours before using, and at the same temperature and for the same length of time after filtration.

Another method often used, and it is accurate, although perhaps more difficult of manipulation, is to aspirate the gas through a meter and catch the dust on a filter as before, measuring the gas volume and weighing the dust. In this method the balancing tubes are dispensed with, but the temperature and pressure of the gas passing through the meter must be determined, and the temperature in the conduit must also be known in order to calculate the dust concentration correctly.

THE MANUFACTURE OF LEATHER BELTING

BY F. H. SMALL,[1] WORCESTER, MASS.

Non-Member

THE manufacture of leather belting has its beginnings on the farms of New England, the grazing ranges of the Argentine, the rocky Alpine pastures of Switzerland, the fertile plains of France—wherever cattle are raised. The cattle supply the hides which are one of the essential raw materials of the tanner and so of the belt maker. It is essential that the cattle industry should prosper if leather is to remain as universally usable a commodity as heretofore. Cattle are raised primarily for their labor value, their milk value and their meat value; the hide is very much of a by-product and the matter of production of a hide specially suited to the requirements of the tanner is but an infinitesimal incentive to the cattle grower. When steer hides sell at better than 26 cents a pound as they have this year, when as much as $40.00 per hide must be paid to secure a particular selection, it seems as though the hide, even if but a by-product, represents a sufficiently large percentage value to secure from the cattle grower an endeavor to produce a satisfactory hide. The tanner, however, has had a hard time to establish this point of view although, aided by governmental agencies whose interests have been different but objective similar, progress has been made.

The particular evils of which the tanner has complained and for which the cattle raiser is responsible are three: barbed wire, brands and grubs. Barbed wire fences lead to scratches on the hair or grain side of the hide, which though they later heal yet constitute imperfections; branding destroys the hide fibre and makes so much of the hide as is touched by the branding iron absolutely worthless for purposes of belting manufacture; grubs are worst of all, for the reason that they do their damage in the very best part of the hide and oftentimes are so numerous that a hide affected by them gives the appearance of having been used as a target for a shot gun.

The first two evils are subject to individual correction; the last can be remedied only by concerted and wide-spread action. It is a question for governmental investigation and legislation. The investigation has been and is going on, but the efficient remedy is not yet, though progress is making. In one district in Denmark, for instance, where they can be reasonably autocratic, by making the presence of warbled cattle in herd punishable by fine, they reduced in six years' time the percentage of warbled cattle from 18 to 1. The above is mentioned for two reasons: *first,* to bespeak your interest in any measures that may come to your attention, calculated to improve the conditions mentioned, and *second,* to show you how uncontrollably imperfect is one of the tanners' raw materials.

Apart from damages as cited there are material differences in hides—differences in texture, in plumpness, in uniformity, etc. It is generally true, for instance, that cattle in warm countries have thick hides and short hair, while in cold climates the reverse is true. Our supply of first quality, extra heavy hides comes almost wholly from southern Europe, and these being no longer obtainable as a consequence of the war we are hard put to it to produce extra heavy leather. Some cattle have hides which are very thick over the kidneys and thin over the shoulders; others show this difference much less markedly.

When the hide is removed, the way in which it is done is again a matter of keen interest to the tanner. Cuts in the hide made by the butcher when taking it off the animal lessen the value very materially. The *take-off* of hides from the large packing houses is usually excellent, the result of specific attention, carefully trained and expert labor. It is quite otherwise with the average country hides taken off by the town butcher, which despite the efforts of the Tanners Associations, are still a source of shame. The flaying is so bad that they rarely bring the price of a packer hide and they represent a real and needless economic waste. Abroad, methods of so-called mechanical flaying have been introduced to avoid butcher cuts. By these methods the hide is pulled and hammered from the carcass and such hides usually command a premium, 50 cents a hide being an average figure at the Paris auctions.

What happens to the hide after its removal from the animal and before the tanner gets it, is again of importance. Hide, being essentially gelatine, readily spoils and must be preserved against decomposition. Two methods of preserving or curing hides are in vogue, viz.: drying and salting. The first is ordinarily too uncertain to permit of the use of hides cured in this way for belting and practically all hides tanned for belting are what are known as green-salted hides.

If the belt manufacturer tans the leather which he makes into belting—and this is the ideal arrangement—he buys so far as possible green-salted hides, free from scratches, brands and grubs, short-haired, of as uniform thickness as obtainable and which have been skilfully taken off, so that they are free from butcher cuts; i. e., the manufacture of first quality belting begins with the purchase of first quality hides.

Before being used for belting these hides must be tanned, i. e., so treated that they will not decompose or spoil and will remain flexible. There are various methods of tanning hides but whatever the method used, the first steps, usually spoken of as the beam house treatment, are essentially the same, namely: preliminary washing with water to remove dirt and the salt or other material which may have been used to *cure* the hide; a cleaning of the flesh side to remove superfluous flesh, fat, etc., left on in the flaying—a soaking in milk of lime, or some other depilatory solution, to loosen the hair which is then pushed off by machine or with a dull two-handled knife; and a final washing to remove at least in part the unhairing chemical and to clean the hide. The quality of the finished leather depends in very large measure on the successful performance of these apparently simple operations. It is an old saying that leather is made in the beam house.

The conversion of the hide as above prepared into leather may be brought about through the use of any one of a variety of tanning materials, the peculiar characteristics of the finished leather being governed by the material used.

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Only a few of these materials will be mentioned and such only as have a special interest to the belt manufacturer. One of the simplest and oldest methods of tanning is to cover the raw hide in the moist condition with grease and then continually manipulate it as it dries, thus working the grease into the inmost fibres of the hide and producing a grease-tanned leather. Grease-tanned leather has little more fullness or body than the original hide, but it is exceptionally strong. The so-called mechanical lace used for lacing together belting is tanned in this way.

Another method of tanning which has come down to us from olden times is to work into the hide a mixture of alum and salt. This gives a somewhat fuller leather than grease and is used before the grease treatment by some tanners of mechanical lace because of the fullness gained, but it is at the expense of the toughness and wearing qualities of the lace.

A modern tannage of somewhat similar nature is that with salts of chromium, the hide being immersed in a solution of one of these salts. Chrome tanned leather is fuller than alum tanned and much more permanent. Water will seriously injure alum-tanned leather, causing it to revert nearly to the condition of raw hide and to become hard and cracky, whereas water has little or no effect on chrome leather. Chrome leather may even be immersed in boiling water for some little time without serious damage to the leather. Most of the so-called steam-proof belting is made from chrome-tanned leather.,

By far the greatest percentage of heavy leather, and in particular that used for belting, is tanned with a tannin derived from some vegetable material. The procedure of the tanning process as early practiced with vegetable materials was to spread the hides out flat in a vat with a relatively thick layer of the tanning material between the hides, the vat finally being filled with water. The water served as a medium of exchange, extracting the tannin from the vegetable material and giving it to the hide which absorbing it became tanned. The process was slow, often necessitating a year or two to effect the conversion of the hide into leather.

An improvement in the process was effected by substituting for the water a tan liquor obtained by leaching the tanning material in large tubs; i. e., extracting the soluble tannin by passing hot water through the ground raw material. Nowadays the use of the raw tanning material by the tanner is almost a thing of the past. He uses instead tanning extract prepared at plants usually located where the supply of raw material is abundant and which is a concentrated solution of tannin obtained by leaching the raw material with water as was formerly done at the tannery, and then evaporating away much of the water in a partial vacuum at low temperature and yielding as the commercial product ordinarily a thick brown liquid containing about 25 per cent actual tannin. Not merely does this supply the tanner with his tanning material in a form much more convenient for use, but it has the further decided advantage that the extract admits much more easily of analytical control and so makes possible the use of a determinate and uniform tanning agent. Since uniform product demands uniform raw material this is an improvement of no mean order.

Not so long ago—in fact as recently as 1890—practically all the vegetable tanned heavy leather in this country was made with either hemlock or oak bark, or a mixture of the two. Now, while the old names, hemlock, oak and union, are still retained, it would be hard to find a tanner making leather with these materials alone. The present-day tanner uses not merely hemlock and oak, but chestnut wood, or valonia, or myrobalans, or mimosa, or quebracho, or wattle, or mallet, or algarobilla, etc., some twenty-five or thirty materials being commercially available.

With an increased range of materials came, of necessity, a study of the leather-making qualities of each. Marked differences appeared. For instance, the tannin of valonia was found to decompose rather rapidly, forming and depositing insoluble ellagic acid. The English tanner, earlier to use these materials, had discovered this by experience, and by using valonia and insuring the deposition of the ellagic acid in his leather, was making the solid English sole, waterproof and long-wearing, which earned him a reputation the world over. A myrobalan liquor was found to sour very rapidly, yielding eight times as much acid, for instance, as mimosa under the same conditions.

The leather-forming value of the materials varied; valonia would produce over 100 lb. of finished leather as against 75 for myrobalans, from the same weight of hide. Chestnut wood produced a leather of tensile strength over 3,000 lb. to the sq. in., while oak bark under similar conditions gave one of less than two. Here certainly was knowledge and opportunity the tanner could not neglect. Knowing what qualities he desired in his finished product, he could, by a careful selection of tanning materials, go far toward securing these qualities, this material making for fullness, that for strength, etc. The progressive tanner, who wanted to make the best belting leather could not afford to make oak belting with oak bark alone, and he did not, and his leather is the better in consequence.

The objection to practically all the tannages, aside from that with vegetable tannin, is that they do not make a plump, full, solid leather. The leather produced by them is tough, but thin and open. The original hide constitutes much the largest percentage of the finished product, only a small quantity of the tanning material remaining in the leather. This is in marked contrast to the vegetable tannage in which so much tannin and other matters is deposited in and on the fibres of the hide that the original hide constitutes less than 50 per cent of the final leather.

Lack of firmness is a serious deficiency in a leather to be used for belting. Nevertheless, leathers made with some of the above materials have sufficiently valuable properties so that they have made considerable headway for belting even despite their failings. Chrome leather, for instance, can be produced in a comparatively short time. It will run practically unharmed in a temperature where vegetable tanned leather would revert to a brittle, formless mass. It can be made exceptionally flexible. It has a high coefficient of friction. Consequently belting from chrome leather has found a place for itself, which would be larger, were it not for the deficiencies resultant from the lightness of the tannage, the lack of solidity of the leather and the necessarily high cost because of the small leather-yield. A leather tanned with a combination of alum and gambier, the gambier being used to supply the deficiencies of the alum as a filling material, has likewise had some vogue. It is tough and pliable, and has given good service for high-speed work.

The latest development in the way of a new tannage is that originated and used by the Graton & Knight Mfg. Co.,

with which I am connected, in the production of its Spartan leather. Spartan leather is a full, reasonably firm and solid leather, resembling in this respect the vegetable-tanned leathers, though more flexible. It has a higher coefficient of friction than chrome and consequently a better pulley grip and it will be remembered chrome is superior to oak in this respect. It is more resistant to heat and harmful agencies in general than chrome or any other leather. We have used it successfully for overload conditions so severe that engineers have said success was impossible. As an illustration, the worker roll on a Vaughn setting-out machine is run by similar belts traveling over similar pulleys at the two ends of the roll; in a service test we were using a chrome belt at one end and a Spartan at the other, alike except as to tannage. One day the chrome belt accidentally came off and to even our astonishment the machine kept right at work with only the Spartan belt in service. As a matter of curiosity we then reversed the conditions, leaving on the chrome belt, but it slipped and the machine refused to work.

It was stated above, that if the belt maker knew what qualities he wanted in the leather from which he made his belting, he could go far toward obtaining these by proper choice and application of tanning material. To enumerate these qualities as our experience has shown them:

First We need good driving surface, sufficient friction between belt and pulley to eliminate slippage as completely as may be and to enable the belt to carry its load under minimum tension, thus avoiding useless waste of power at the bearings;

Second Lateral stiffness coupled with pliability, the stiffness to keep the belt from twisting and waving and to prevent its curling at the edges when shifted; the pliability to enable it to hug the pulley, wrapping itself round and so securing large arc of contact, and to enable it to alter its shape with the minimum of internal resistance as it travels round the pulley;

Third Good tensile strength that it may carry its load without breaking;

Fourth Little stretch but considerable elasticity; the former so that it will need to be shortened as seldom as may be, i. e., will do its work uninterruptedly; the latter so that it may easily take up and let go its load as it travels round the pulley;

Fifth Firmness or stability, much the same as lateral stiffness, so that the leather springs little when cut, holds its shape, remains straight and runs true on the pulleys;

Sixth Resistance to external conditions, such as heat, moisture, chemicals, etc.: that it may do its work in any place, at any time, and enduringly;

Seventh Low initial cost.

It is apparent that no leather can have all these qualities in the highest degree, for some of them are incompatible. Sole leather would do admirably as far as lateral stiffness, little stretch, and firmness are concerned, but would fail lamentably to satisfy the requirements of pliability, tensile strength, elasticity, etc. The best result we can achieve is bound to be somewhat of a compromise. We must aim to get the largest measure possible of the most desirable qualities in our leather, with the least necessary sacrifice of others. There is where the beltmaker who tans his own leather has a marked advantage in that he may bend all his efforts to so adjusting his tannage as to secure the best possible compromise. Quality belting demands then,—first, suitable hides,—second, suitable tannage.

We now have the leather and may proceed to prepare it for making into belting. Of the hides which we have tanned only 50 per cent may legitimately be cut up into belting and less than 40 per cent will go into first quality belting. First, we reject the bellies, cropping or cutting them off at the flank; this loses us 25 per cent of the hide. Next we cut off the shoulder at a point 4 ft. 4 in. from the tail or, if the hide be exceptionally small, at a less distance; this loses us 25 per cent more, leaving us for cutting into belting a "bend" which constitutes less than 50 per cent of the original hide.

This bend has now to be curried, i. e., given a supplementary grease-tannage; set out—to give a smooth flat piece of leather—and then stretched. The stretching is done on frames in which the wet leather may be clamped and subjected to so much tension as desired, the leather being allowed to dry under tension on the frames so that an additional stretch resultant upon the natural shrinkage of the leather in drying is imparted to the leather. Before being stretched the bend is usually cut into a center and two side pieces, inasmuch as the center portion being more close fibred will not stretch as much as the side pieces and by being divided as above the leather can be stretched more in accordance with its capacity. After stretching the leather is rolled and glassed to improve its looks and is then ready to go to the stock room.

When the leather is received in the stock room, it is sorted according to weight or thickness—which in this connection are practically synonymous terms—into extra heavy, heavy, medium and light, and then packed down for future use. The sides are packed in square piles, alternate layers at right angles, to keep the stock flat and straight and allow of a circulation of air through the pile, thus aiding and hastening the seasoning process. This seasoning is an often neglected but most desirable operation, for the use of well seasoned leather is as important in the manufacture of belting as the use of well-seasoned lumber is in building. Belts made from well-seasoned stock stretch less and more uniformly, retain their elasticity and wear longer than belts from green stock.

From the stock room the leather goes to the belt shop where its manufacture into belt takes place. The first step in this process is to straighten one edge of the leather. Next it is cut into strips of various widths by passing between a rapidly revolving circular knife and a guide, the strips being graded for width and roughly for quality as they come from the knife, and then stored in racks. From these racks the leather goes to the sorters by whom it is most carefully graded, both for thickness and quality, and on their expertness depends the maintenance of the standard set for each brand of belt. Accurate judgment of quality depends on wide experience in handling leather and a good all-round knowledge of the specific characteristics of the leather in different parts of the hide, for it is a fact that no two square inches of hide are precisely alike.

Quality, however, is very elusive of definition when one tries to imprison it in the confines of a specification and the buyer is fully as likely to be well served if he states his needs and trusts to the honesty of an established and reputable house as if he attempts to be his own judge. The author has in mind a large railroad buying belting accord-

ing to a specification which called for the leather to be cut from strictly first quality belting butts and they were getting it, *necks* and all. Inasmuch as a belt is no better than the poorest strip in it, similar to the chain that is no stronger than its weakest link, it may be imagined how well they were being served. Later when the author's company had an opportunity to supply this railroad with some belting, we were rather chagrined to have it rejected by the railroad inspector. Some rolls of stock belt of a grade distinctly inferior to that first offered were then submitted and accepted by the inspector with a cheerful response: "That's what we want; why didn't you give us that at first?" For our own ultimate good we have been trying to educate that railroad on this subject of quality in belting.

Returning to the process of manufacture, after the strips have been sorted, they then go to the *fitters* to be matched and have the laps marked. Pieces cut from the right side of the hide are matched with pieces cut from the left side, because all strips which are not backbone center pieces will stretch in a curve if subjected to a sufficient strain. Narrow strips from a properly stretched side, merely as a result of the stripping, contract to a slight curve. Belts made by joining alternately rights and lefts will roll out in a curve on the floor but will run true upon the pulleys, while belts in the construction of which no attention is paid to the matching of rights and lefts will roll out straight on the floor but will invariably stretch crooked if subjected to sufficient tension on the pulleys. Not all belts show these characteristics noticeably because not all belts are required to transmit sufficient load to develop them early enough in the life of the belt for them to attract attention.

The laps are marked according to the thickness of the stock and usually range between 4 in. and 10 in. in length. Laps must be longer on the shoulder end of the piece because hides become thinner, taper off faster, near the shoulder than near the rump, and longer laps are needed therefore to maintain a uniform thickness of belt. Shoulder ends are joined to shoulder ends and butt to butt because the length of the laps match better, the thickness is more uniform, the stock is similar in quality and the component parts will therefore wear and stretch more uniformly. The laps are next scarfed and prepared for cementing.

The usual cement employed to stick the laps has for its basis animal glue. Each manufacturer is likely to have his own pet formula calling for certain additions to the glue solution and particular methods of compounding, but they all look much alike. By this it is not meant to disparage the cement, for a cement that will hold as long as the leather will wear, is a necessary component of a quality belt. About twelve years ago saw the beginnings of the now indispensable waterproof cement. Laps stuck with this are absolutely unaffected by water, either cold or hot. Whatever cement is used the process of *sticking* is the same in its essentials. The surfaces of the leather to be joined are coated with the cement, put together in their final position, placed between the plates of an hydraulic press and subjected to heavy pressure. From the presses the belt goes to the inspector and then to stock.

The above description applies more particularly to single belting, but the processes are much the same if double or three-ply belting is to be made. A liberal quantity of stock which has been scarfed and the flesh side of which has been cleaned up with a scraper to remove grease, loose flesh, etc. (this being the side which is cemented) is placed upon the fitter's bench. He matches these together on a smooth surface against wooden blocks which are his standard of thickness, the pieces being matched to secure as uniform thickness as possible and so that the laps of one ply come about half way between the laps of the opposite ply.

In conclusion, I wish to emphasize the fact that the idea that a belt is a belt and one need merely cut off a piece of the requisite length and put it on the pulleys is no longer tenable. Proper mechanical conditions and adaptation of belt to drive are just as essential to economy of operation as is the suiting of a motor to the work it has to do. As illustrating the first might be mentioned a three pulley quarter-turn drive with fixed idler that came to our attention. This required an 11 in. belt and was called upon to transmit 100 h.p. The best belt procurable lasted about two months on this drive. Changes in the plant demanded more power from the drive and it was altered to a five-pulley quarter-turn, which necessitated the use of nearly three times the former length of belt. A belt an inch wider is delivering double the horse-power and is good for at least ten years.

Returning to the railroad, their theory of operation was to keep rolls of belt in stock and cut off a length as it was needed. On one machine of which they had record, the average life of a belt was six weeks. Our belt man succeeded in securing the installation of a belt suited to the drive and at last accounts this belt had been in operation over six months and was apparently then in perfect condition.

Another illustration of suiting the belt to the drive: A customer complained that an 18 in. edger belt furnished him was not working satisfactorily and one of our belt men investigating the conditions, found that at the high speed at which the belt travelled, the load was not sufficient to keep the belt down on the pulleys, the edges raising. The belt was narrowed two inches to 16 in. and did the work perfectly. An opposite case was that of a 6 in. light double belt on a high speed drive, long centers, power off and on frequently. The belt jumped so badly it could not be used. A heavy double was substituted and the trouble ceased at once.

The weave room in a cotton mill was belted with medium weight first quality belts and the plant was not a paying proposition. A study of conditions convinced our belt engineer that they were using too light a belt and the belts were replaced with heavier first quality belts, and the plant was able to pay dividends.

Another similar illustration: Our salesman recommended a light double belt for a mill drive, the master mechanic of the mill insisting on a heavy single. There were several similar drives, so one of each was installed. The record of the belts was that the double was taken up and shortened 2 in. five days after installation and not touched again when this record was completed, while the single was shortened 2 in. the day installed, $2\frac{1}{2}$ in. two days later, 4 in. three days after this, 3 in. more sixteen days later, 3 in. more forty-six days later, and 5 in. again after 29 days more, when it was practically worn out.

The subject has been so large for the time at disposal that this talk may have been much cursory and little interesting. It however may have served its purpose if it has shown you something of the problems of the business and of its ramifications—that many of its simplicities are really complexities.

AN INVESTIGATION OF THE GAS-PRODUCER POWER-PLANTS IN NEW YORK CITY AND VICINITY

BY C. M. RIPLEY,[1] NEW YORK

Non-Member

THE object of personally visiting all the gas producer plants in New York City and its environs was to acquaint the author with the progress which had been made in the use of gas producer power plants and the present status of the industry as applied to a large city and its suburbs. It had been suggested that most of the information available to owners and engineers on this subject emanated from the sales departments of various manufacturers; also that these manufacturers report only upon plants which they themselves install and then upon only the more successful ones; and that an unbiased investigation might be interesting to the Gas Power Committee of the American Society of Mechanical Engineers, and also to those of the business community who operate properties involving large annual expense for heat, light and power.

The investigation covers the size, age and performance of the gas producer plants and a census was taken of owners' opinions regarding repairs, labor and depreciation. The three different phases of this investigation are as follows:

I. A census recording owners' opinions. (Table 1).
II. Technical data, showing capacities, performances, etc. (Table 2).
III. General information from personal inspection and interviews.

On Tables 1 and 2 plants are arranged according to their size, i. e., from 1000 h. p. down to 30 h. p. of producer capacity. In the division of general information the plants are taken up according to their age in service, i. e., from sixteen years down to less than one year.

CENSUS OF OPINIONS

To each of the owners of gas producer plants in this district was written the following letter:

Gentlemen:

I wrote you early in the month requesting a "yes" or "no" answer to these questions about your gas producer plant:

Ques. No. 5. Are repairs in excess of your expectations?
" No. 6. Is depreciation in excess of your expectations?
" No. 7. Is labor charge in excess of your expectations?
" No. 8. Are you availing yourselves of the heat in jacket water and exhaust?
" No. 9. If you were to construct another building for similar uses would you again install a gas producer plant?

The idea of this investigation of all the gas producer plants in New York City and in near-by towns in the Metropolitan District is to ascertain the progress made by gas producers, their present status and the general opinion of those who operate them.

In return for this information I will be pleased to send you a copy of my complete paper with charts and the result of the census. It will be interesting for you to know what the other users of gas producer plants think of this system of power, and in the future if anyone asks information of you about your plant you can refer them to the library of the American Society of Mechanical Engineers, where in all probability their questions will be answered.

Thanking you in advance,

Yours very truly,
(Signed) C. M. RIPLEY.

The answers to these questions are tabulated in Table 1 and lead to a most interesting conclusion as to the present status of large gas producer plants. As a constructive criticism it is to be hoped that manufacturers will profit by a study of this chart and that their product will be improved where weakness has been shown. That this will be the case in the next few years the author feels confident.

The fact that 78 per cent of the gas producer plants in this territory gave definite answers to a majority of the four questions indicated at the top of the chart, is very gratifying. It will be noted that 86 per cent of the large plants, i. e., 250 h. p. and larger, answered the questions fully, whereas but 74 per cent of the small plants gave answers to these questions.

In regard to question No. 5, it is interesting to note that 80 per cent of the large plants report repairs in excess of their expectations and that only 6 per cent of the small plants so reported. The satisfaction with the small plants in regard to this question is indicated by the fact that 94 per cent of them answer "no."

In regard to question No. 6, 56 per cent of the large plants report depreciation in excess of their expectations, while 94 per cent of the small plants report the contrary.

In regard to question No. 7, 50 per cent of the large plants report attendance costs in excess of their expectations, while 88 per cent of the small plants do not find this to be the case.

Question No. 9 asks for opinion as to installing a gas producer plant in case a new factory were to be built. 50 per cent of the larger plants answer "yes," 30 per cent "no," and 20 per cent are doubtful. Should this 20 per cent be interpreted as meaning "yes," then the large plants would indicate 70 per cent favorable answers against 86 per cent favorable answers from the small plants. Should "doubtful" be interpreted as "no," then 50 per cent of the large plants may be considered unsatisfactory as against 14 per cent of the small plants.

Attention is invited to this Table as it gives a tabular measure of satisfaction and dissatisfaction. The answers as shown to the four questions constitute practically a curve in which satisfaction is plotted against size, and can be visualized without difficulty.

TECHNICAL DATA

In Table 2 will be found information as suggested for convenience of reference and comparison, from which it will be gathered that there are fifteen gas producer plants in New York City, and a total of thirty-three in operation in the Metropolitan District. This is in addition to two

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Presented at the New York local section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, on November 9, 1915.

experimental gas producer power plants, three gas producer plants used for furnaces only (not in connection with power plants), and seven gas producer power plants which have been abandoned.

Kind of Coal Used. It will be noted that only two of the thirty-three plants referred to above are using bituminous fuel, all of the rest using either pea or buckwheat anthracite.

One general impression obtained by the author is that only slightly more fuel is used in these plants for a 24-hour run than for a 12-hour run. This is due to the following, as stated by one expert in gas producer operation:

TABLE 1 CENSUS OF OWNERS OPINIONS

No. of Plant	H.P. Not answered	H.P. answered	Ques. 5		Ques. 6		Ques. 7		Ques. 9		
			Yes	No	Yes	No	Yes	No	Yes	No	?
1		1000	+		+		+				+
2	1000	New plant just started									
3		700		+		+		+	+		
4		600	+		+		+			+	
5		600	+		+			+	+		
6		600		+		+		+	+		
7		400	+			+		+	+		
8	400										
9		300	+		+		+			+	
10		300	+					+	+		
11		275	+			+	+				+
12		250	+		+		+			+	
13		200		+		+		+	+		
14		200	+		+		+			+	
15		200		+		+		+	+		
16		200		+		+		+	+		
17	200										
18		180		+		+		+	+		
19		150		+		+		+	+		
20		150		+		+		+		+	
21	125										
22		150		+		+		+			
23		100		+		+		+	+		
24		100		+		+		+	+		
25	100										
26		50		+		+		+	+		
27		50		+		+		+	+		
28		50		+		+		+	+		
29	56										
30		50		+		+		+	+		
31		50		+		+	+			+	
32	40										
33		30		+		+		+	+		
Total	1921	6935	9	17	6	19	7	19	17	6	2
Per cent of number	22	78	35	65	24	76	27	73	68	24	8
% 250 HP or larger	14	86	80	20	56	44	50	50	50	30	20
% 200 HP or smaller	26	74	6	94	6	94	12	88	86	14	0

It is common practice in the majority of gas producer plants to remove more or less green fuel with the ash, when cleaning fires. Usually the percentage of combustible matter in the ash grows smaller as the hours of operation increase and the load on the producer approaches a maximum.

In a producer that is underloaded and running on an average of 10 hours in the twenty-four, combustion is not rapid enough to allow for lowering the entire fuel bed, and more or less green fuel is removed by the average operator, this being an easy and convenient way of maintaining the fire in a good gas-making condition.

A skilled operator can usually obviate this difficulty by studying his fire and cleaning it according to the position and amount of the ash. His method would be approximately as follows: A normal fuel bed produces an ash deposit, the part of which in contact with fuel, has the shape of a bowl. This is due to the draft following the sides of the producer and in case of an underload on the fire and the draft being reduced, a larger percentage follows the sides than would under full load conditions.

This means that the operator must clean the side walls thoroughly and practically leave the centre of the fire untouched. As the majority of producers are so designed that this is a task which only a skilled operator can perform successfully without removing considerable green fuel mixed in the ash, the average plant shows a large amount of combustible matter in the ash.

Different types of producers are more or less adapted to meet these conditions. The type designed in such a manner that the fuel bed rests on a solid ring on the side and a shaking grate in the centre, meets the above conditions better than any other. It enables the operator to remove the wall ash a little at a time and by poking around the wall, between the removals, to gradually lower the bed at this point to the proper level, without losing any good fuel. After this is done, by shaking the grate, the centre also can be cleaned.

Where the fuel bed rests entirely on a shaking grate, if the walls are cleaned in the manner described, green fuel is shaken down when the centre is lowered. If the grate is resorted to to lower the entire fuel bed, much good fuel is removed from the centre before the walls are properly clean.

In producers using a turn-table and bars to scrape off the ash accumulation the same result follows. In producers having a water seal, and relying on the cone effect of the ash bed around a tuyere, to allow for the removal of ash of the shell, runs occur owing to the fact that the operator cannot see the fire as he works it, and does not know at any time the exact position of the fire. All these difficulties may be more or less overcome by a skilled operator who studies his fire.

The fact that a producer can be run 24 hours with much less fuel in proportion to the load carried, than for 10 hours, is due to a great extent to the foregoing. A normal producer, if properly handled, should show a standby loss of not over 5 per cent of the grate rating. Also standing idle tends to make the fire climb into the fuel magazine and due to the heat generated, cause the operator to pull more or less fuel in order to permit the addition of more green fuel to cool the top of the producer.

Any moisture entering the bottom of the producer when it is standing idle, tends to drive the fire to the top and leave the bottom filled with partly consumed and useless fuel.

These conditions may not apply in all cases but nearly all fuel waste is traceable to them (in one form or another) or to poor design.

Height. It will be noted that considerable headroom is needed for the gas producers even in the small plants. This, however, has been overcome in two plants by locating the producer out-doors, thus saving excavation, and with apparently no bad results. In regard to the space occupied by the producers, it is surprisingly small in relation to the amount of power obtained from them.

Attendance. It will be noted that the anthracite plants seldom need over six charges a day even for a 24-hour run, and the cost of firing is small indeed. In fact operating men consider the firing, as far as the amount of time is concerned, a great advantage as firemen can be useful at other work during a vast majority of the time. In many cases the engineer does the charging himself as it requires so little time and effort, especially with the electric hoist or other coal elevating devices. The removal of the ashes under these conditions is left to a laborer. The operation of plants of 300, 400 and 600 h. p. with the consumption of one, two, three and four tons of coal per day is to be noted, several cases showing these results in a 24-hour run.

GAS PRODUCER POWER PLANTS
NEW YORK CITY AND METROPOLITAN DISTRICT

No. of Plant	NAME OF CO.	CITY	PRODUCERS	TOTAL HP.	ENGINES	TOTAL HP.	DYNAMOS	TOTAL KW.	VOLTAGE	TOTAL COST	HT. OVER ALL	SPACE	NO. CHARGES DAILY	MAX. LOAD	AVE. LOAD	HOURS RUN DAILY	FUEL DAILY	FUEL PER HP-HR.	LUBRICANTS	ATTENDANCE	AV. REPAIRS YEARLY	AGE (YEARS)	KIND OF COAL
1	ATHA TOOL CO.	NEWARK, N.J.	2	1000	4	640	4	325	250	75000	40 FT	P 30x30	250	*	*	12	8 TONS					5	BIT
2	L.O. KOVEN BROS	JERSEY CITY	2	1000	1	150	1	100	250		50	70x75		*	*							½	BIT
3	HORTON ICE CREAM CO.	N.Y. CITY	2	700	6	675	3	450	250 125	55000	25	P 24x30		**	**	24	4 TONS	1.35				5	BUCK
4	AMER. COTTON OIL CO.	JERSEY CITY	3	600	2	600	2	400	125		40	P 22x45	3		6000A	24	9½					2	PEA
5	SWIFT & CO.	N.Y. CITY	3	600	4	400	4	300	250		30	P 20x20	4	**	** 450A	24	3½			6		8	PEA
6	NATIONAL METER CO.	N.Y. CITY	2	600	3	550	3	350	125	30000	30	P 40x16	2		225 KW	11	3	1.7†				9+3	BUCK
7	PHOENIX TUBE WKS.	N.Y. CITY	2	400	4	535	3	300	115		20	P 20x20	1			10	1.1			1		13 5+4	PEA
8	ERIE R.R.	JERSEY CITY	2	400	7	552	3	230	110 2400		35	P 20x40	8	***	***	24	2			3+		16	PEA
9	CASTLE ICE CREAM CO.	NEWARK, N.J.	1	300	1	300	1	200	125 250	18000	20	P 20x30	4	500A	730A	24	3½		80 gal per Mo	4	$1500	1	"
10	MERGENTHALER LINOTYPE CO.	N.Y. CITY	1	300	1	300	1	200	125 250	35000	OUT DOORS	P 15x15	2			10½	2 1/3	2.0†				2	"
11	MAX AMS MACH. CO	MT. VERNON, N.Y.	2	275	2	175				20200					142 HP	11	¾	1.12				8	"
12	DE LA VERGNE MACH. CO	N.Y. CITY	1	250	1	75	1	25	115		30	P 15x25	1	***	***	11	¼					7	BUCK
13	KEYSTONE WATCH CASE CO	JERSEY CITY	1	200	2	170	2	125	220	15000	20	P 12x18	21	* 400A	* 500A	11	1½			2	$300	7	PEA
14	AUTO PRESS CO.	COLLEGE PT, L.I.	1	200	1	133	1	100	240		20	P 14x14	1	1868 KWH per wk	80 KW	9	1¼			$25 per week		5	"
15	JOHN THOMPSON PRESS	L.I. CITY, N.Y.	1	200	2	185	3	175	250		20	P 12x20	8	165 HP		11	1/8	1.29		$43 per week		9	"
16	ACME ELEC. GARAGE	N.Y. CITY	1	200	3	300	3	200	125 250	30000	20	40x40	2	2000 KWH per day	1650 KWH per day	24	2			2		1+4	BUCK
17	T. SCHRIVER & CO.	HARRISON, N.J.	2	200	3	150	6	69	250		15	30x30				9½						8	PEA
18	CHAS. MUNDT	JERSEY CITY	1	180	2	175	1	5	230	5500			2	***	***	14	1/3	1.12		1-		8	"
19	GEO. F. HEINRICHS	N.Y. CITY	1	150	2	270	2	174	125 250		20	P 12x12	8		110 KW	16	1.1			1+		5	"
20	LUDWIG PIANO CO.	N.Y. CITY	1	150	1	100	1	75	230		15	P 10x25	6			11	1.1			2		7	"
21	STROBELL & CRANE	NEWARK, N.J.	1	125	1	89	1	50	125		14	11x25	6	*** 250A	*** 300A	10	½			1+		9	"
22	HOOTEN COCOA CO.	NEWARK, N.J.	1	150	1	150	1	100	220	15000	25	P 25x25	6	400A	500A	11	½	0.94	2 gal Daily	1+	$33	5	"
23	HAWLEY & HOOPS	N.Y. CITY	1	100	1	80	1	75	230		14	P 10x20	5			10½	½	1.12		1		9	"
24	WINELANDER & JACKSON	N.Y. CITY	1	100	1	85	1	15	110		18	P 20x20	1	***	***	12	½		8 qts daily	1-	$79	4	"
25	UNIVERSAL METAL BED CO	N.Y. CITY	1	100	1	100	1	¼	115		17	P 26x16		***	***	10	½			1		6	"
26	THOS WRIGHT WAGON SHOP	JERSEY CITY	1	50	1	35	1	7	115	3640	15	12x30	4	***	***	9½	1/3		$2 per Mo	1-	$52	9	"
27	McCABE HANGER CO.	N.Y. CITY	1	50	1	50	1	30	250		15	25x25	4	180	120	10	⅔			$70 per Mo		6	"
28	PIRIKA CHOC. CO.	N.Y. CITY	1	50	1	45	1	10	115	4200	OUT DOORS	P 15x15	1	**	**	11	¼	1.12	$15 per Year	1-	$10	9	"
29	ERIE R.R.	CROXTON, N.J.	1	56	1	56				SEC HAND	25	20x30		***	***		¼			1-		3	"
30	LEIMAN BROS.	NEWARK, N.J.	1	50	1	40	1	5	115	SEC HAND	12	P 12x12	3			11	¾			1-		8	"
31	N DRAKE CO.	NEWARK, N.J.	1	50	1	50					18	P 10x25	1			11	½			1-		9	"
32	ALLSOPP BROS.	NEWARK, N.J.	1	40	1	40					12	P 6x15	3	***	***	11	1/3			1		7	"
33	GEN'L CEMENT PROD. CO.	L.I.	1	30	1	28	1	18	115	3300	15	10x10	1	***	*** 50 A	24	1/8		$5 per Mo	1	$70	9	"
	EXPERIMENTAL																		†Per kw-hr.				
	Stevens Institute	Hoboken N.J.	1	30	3	29	1	7½	125														
	Stand. Motor Const. Co	Jersey City	2	300																		7	
	FURNACES ONLY																						
	Cork Insulating Co	Jersey City	2	400										*		24	12			2		2	½ pea ½ buck
	Hyatt Roller Bearing Co	Harrison, N.J	3	1500										*								1	Bit
	Crucible Steel Co	Harrison, N.J	2											*									
	PRODUCERS DISCONTINUED																						
	N.J. Adamant Mfg Co	Harrison, N.J	1	50	1	30				Sold												3	Pea
	Harper Brick Co	Harrison N.J	1	27	1	27				Sold												2	"
	Newark Spring Mattress Co		1	50	1	38				Sold to Leiman Bros												4	"
	C.E. Hertlein	N.Y. City	2	285	3	300				Sold - 2 plants - both failed - Now use Steam Elect.												1	"
	Cameron Mach. Co	N.Y. City	1	50	1	50				Sold						9	1/3			1		3	"
	Manhattan Screw & Stamp. Wks	N.Y. City					1	75		For sale. Firm retired from business													
	Advance Machine Co.	N.Y. City								Second hand. Never unboxed - For Sale												2	

* = Furnace Gas Load ** = Belted Refrigeration Load *** = Belted Power, Pumps, Compressors etc. P = Space for Producers only

TABLE 2 TECHNICAL DATA OF GAS PRODUCER POWER PLANTS IN NEW YORK

As a general impression, it would appear that the importance of skill on the part of the engineer in charge is greater than estimated by the average salesman, and several owners have engaged second and third class operatives and paid the price to their sorrow. To a large extent this error is, in the author's opinion, to be laid at the door of the sales departments of the manufacturers, and it is hoped that they will advance their interests by being more careful as to their claims in the future. It is true that the firing of the coal is a very small matter, but the care of the gas engine and producer cannot be entrusted to a third class man or a laborer, as some have vainly attempted to do.

Some owners are using the unconsumed coal in the ashes for firing boilers, and one owner carries it to a point that he not only heats his factory but his residence with the mixed ash and coal removed at the end of the day's run.

GENERAL INFORMATION

The Oldest Gas Producer Plants. The oldest gas producer plants in operation in the territory investigated is at the Erie Railroad Company's terminal in Jersey City, N. J. For 16 years the same producers (Wood pressure type) have been in use and while the Railroad Company refused to contribute to the author's census of opinions, their satisfaction may be gathered from the fact that they have made additions to this power plant upon two separate occasions. Two 90 h. p. Otto engines were later supplemented by three Otto and one Westinghouse engines, and later again augmented by another Westinghouse engine. William S. Young is the mechanical foreman of this plant. Both alternating and direct current electricity is generated and both direct connected and belted drives are used.

Another old plant is that at the Phoenix Tube Works, Brooklyn, which for thirteen years has had no other source of power than gas producer plants. They use one Smith and one Tait suction producer, and as in the previous instance, have twice enlarged their plant. They have, for attendance, but one man who does his own charging and that but once per day of 10 hours. If they wish to run at night they run one of their engines with city gas. The engines are direct-connected to electrical generators.

In the tenth year of service is a plant owned by Thomas Wright, wagon maker, in Jersey City, N. J. In an interview Mr. Wright said: When we purchased electricity it cost $6.25 per day for power. When we purchased street gas and ran our gas engine it cost $4.85 per day for power. With the present plant it costs $1.00 per day for power. I wish to go on record as saying that had I not invested in this economical plant when business was good in 1905, I would have been forced to retire from business.

This plant has had several shut-downs due to careless handling, and in his letter Mr. Wright states that the gas producer plant is profitable but the man taking care of same must be useful and interested. He also states that his repairs from 1906 to 1914 have been so small that he hardly notices it. Also, that the labor charge is not excessive, considering what they would have had if operating a steam engine. His engine is chiefly belted to the load.

Plants in Ninth Year of Service. The Pirika Chocolate Co., in Brooklyn for nine years, have depended on their gas producer plant for power and for a great deal of their heat. Mr. George C. Stout says, "If all gas producer plants ran as ours has run, there would be no other kind of power plant in the world." This plant emits no smell, the producer being located out-doors, and they state that the increased consumption of fuel during the winter months, which they attribute to the location of the producer, is only thirty pounds, or 6c. per day. The firing requires one hour per day of a ten dollar a week man. The repairs to the producer outfit for eight years have been about $40.00 and the repairs to the engine have cost about $50.00.

Twenty-eight kettles are heated at the Pirika plant by forcing the cooling water from the jacket of the engine through the kettles by means of a small electric-driven turbine pump, using one ampere. The cooling water goes into the jacket at 160 deg. and emerges at 190 deg. fahr. It is quite an achievement to run a factory building 35 x 110 ft., three stories and basement, and burn only 75 tons of fuel per year. Mr. Stout opened his records for years back and showed the average to be no greater than as shown above. Smith producers and Nash engines are used in this plant, belt-connected to the load. They used a barrel of oil a year for engine lubrication.

Hawley & Hoopes, another candy manufacturer, on Manhattan Island, New York, have used a gas producer plant for nine years. They also have a steam plant and electric connection from the street for night work. They use Wood producers and Westinghouse engines, direct connected, and the plant gives entire satisfaction.

Strobell & Crane, jewelry manufacturers in Newark, N. J., who occupy a building 75x160 ft., five stories high, operate an Industrial gas producer and Westinghouse engine, direct connected to a generator and belted to other power. The engine has run nine years and ran six years without the cylinder heads being taken off. They also have a connection with the street electricity.

The John Thompson Press, Long Island City, has operated a gas power plant for nine years. This power plant is in a separate building and the plant gives satisfactory service. The factory building is 80 x 165 ft., three stories in height. A Wood producer and Nash gas engine, direct connected to the generator, are used. George W. Day is chief engineer.

The National Meter Co., of Brooklyn, have a gas power plant comprising Smith producers and Nash engines, direct connected, nine years old, which was enlarged three years ago and again two years ago. The building is 50x315 ft., four stories high, and the grounds surrounding it are 200x500 ft. This plant developed 12,200 kw-hr. per week of 55 hours and is only charged twice per day. An electric hoist is used to advantage for charging each of the producers. They sold their steam engine and have no connection with the street electricity.

N. Drake, at Newark, N. J., has a nine-year-old plant in his coal and wood yard and grain elevator. They have had no trouble since the first three months and charge but once a day for an 11-hour run. The attendance is less than one-half of one man's time in addition to the supervision of Arno Morgner, foreman. The engine is belted connected to the load.

Plants in Eighth Year of Service. Leiman Brothers' pump works at Newark, N. J., give an interesting example of the reincarnation of a dead gas producer plant. These people for three years have operated with entire success and satisfaction a plant which was an utter failure during the five years it was at the Newark Spring Mattress Co. The Mattress Co. abandoned the plant in disgust and changed to

street electricity at less than three cents per kw-hr., but refused to state the exact rate which induced them to abandon the unsatisfactory plant.

Mr. George Leiman, of the above company, obtains from the ash of his gas producer enough coal throughout the year to heat his factory and one other building. The attendance of this plant requires two hours daily of a helper and the careful attention of the foreman of the shop, who is a first-class mechanic. Mr. Leiman states that they have less trouble than with the ordinary steam plant and is entirely satisfied with the outfit.

Another eight-year old direct-connected plant is at the Max Ams Machine Co., of Mount Vernon, N. Y. They wrote in 1913, "Very well satisfied with the system and would not exchange for a steam plant, nor will we consider a steam plant when we are in need of an additional plant." Their answer to the census in 1914 indicates a growing interest in the semi-Diesel oil engine. They use the De La Vergne gas engine, which the De La Vergne Co. state they no longer manufacture.

The McCabe Hanger Co., on Manhattan Island, have used for eight years an Otto engine and producer. This is of low speed and noisy, but is very compact and emits no smell. The owner has a well for cooling water. In the eight years of operation, he claims to have had but one shut-down due to the engine and no shut-down due to the producer. There were twelve stoppages, however, due to bad bearing lubrication. Mr. McCabe's opinion is that producers below 100 h. p. are more satisfactory than those over 100 h. p. Mr. McCabe's plant is less than 100 h. p., direct connected.

Swift & Co., in the Bronx Borough, N. Y., have operated a large plant for generating electricity and refrigeration for eight years. Smith suction gas producers and Rathbun-Jones engines are used, direct connected to generators. The refrigerating machines are driven by motors. The plant is never shut down. Mr. W. F. Frazer, the chief engineer, says that, properly cared for, the labor charge is the same as a steam plant of the same size. A low pressure heating system is installed in the upper portions of the building. They are availing themselves of the heat in the jacket water and exhaust only for heating a small amount of water required as a spray in the producer.

Charles Mundt, of Jersey City, whose business is to punch metals up to ½ in. in thickness, has a factory 50x250 ft., two stories in height, and has operated on gas power for eight years. The man who cares for the engine and producer works regularly in the shop. This plant has been enlarged and improved, and the old engine is used with city gas as auxiliary. Otto producers and engines are used, belt-connected to the load.

T. Shriver & Co., Harrison, N. J., conduct an iron foundry and machine works and for eight years have used gas producer power. They charge but twice during the day's run and have one Otto producer and engine and one Westinghouse producer and engine, both belt connected to the load. They did not answer the census.

The Universal Metal Bed Co., Brooklyn, N. Y., lease a building and producer plant formerly operated by the Star Engravers' Supply Co. This plant is eight years old. Mr. R. J. Zapkin is superintendent, and supplied this information.

Plants in Seventh Year of Service. The Keystone Watchcase Co., Jersey City, N. J., have for seven years operated a Harvey producer and two Westinghouse engines, direct connected to electric generators. They have had no shutdowns in the last several years. They also use producer gas in the brass foundry and in ten forges. The engine room is cool and light and has almost no odor. They have a steam auxiliary.

The De La Vergne Machine Co. have operated a gas producer plant for seven years, but state that they have ceased manufacturing them.

The Ludwig Piano Co. have a six-story factory in the Bronx, New York City, and have operated a Koerting gas engine and suction producer for seven years. When inspected they were adding a 200 kw. steam engine, as considerable steam is used in their drying rooms. The chief engineer states that he can start up his plant in 25 minutes, including the making of a fresh fire. The coal withdrawn with the ashes at night from the producer is burned under the boilers. Granville Gibbons is chief engineer. He states that when the producer was being repaired they ran the engine with street gas.

Allsopp Brothers, jewelry manufacturers, of Newark, N. J., have a factory 30x100 ft., five stories high, and have operated a Backus engine and producer for seven years. They are operating apparently satisfactorily in a cool room. The engine is belted to the load and the electricity from the street is purchased for light only. They have gas connection with the street.

Plants in Sixth Year of Service. The General Cement Products Co., and the Auto. Fire Protection Co., who are the joint tenants in a two-story 50x100 ft. factory building at Whitestone, L. I., have operated a producer gas power plant for six years. Smith suction producers and Nash engines are used. Mr. Thurston, the chief engineer, states that all machinery is motor-driven. The producer is charged once a day, in the morning, with 250 lbs. of pea coal. At 6 P. M. the shop is closed and locked, leaving the belted engine running alone all night, carrying a 50 amp. night load, which it is claimed has been done for four years. During this time the plant has supplied electric light for a residence, barn, and outdoor lighting on the country estate of R. L. McElroy adjoining. Also, electricity is used for cooking twenty meals per day at the residence. The supply of electricity for this residence, it is claimed, supplants an electric bill of $320.00 per month at an expense of less than $85.00 per month, including interest and depreciation. The residence contains a Simplex No. 11 cooking range, which replaced an old coal range five years ago. When cooking with coal it required two tons per month of $6.00 coal. With the electric range and the increased electric consumption for operating same, the producer burns one ton per month extra at $4.00 per ton. Besides the electric range are three electric irons, three electric hot plates, a waffle iron, one electric toaster and one electric percolator.

Plants in Fifth Year of Service. The Horton Ice Cream Co., New York City, who operate an ice cream factory, 200x100 ft., five and six stories in height, have used producer gas for five years. Besides operating forty motors for machinery, they also operate seven electric elevators. The total motor load is 810 h. p. The engine room is cool and quiet, but the producer room is terribly hot. This latter condition is largely because tenants in the apartment houses

nearbly complained of the noise of firing, and in deference to their wishes the company bricked up the producer room at the expense of ventilation. H. J. Ayers is chief engineer. Tait suction producers and Rathbun-Jones engines are used, direct connected to electric generators.

The Atha Tool Co., Newark, N. J., who have been using producer gas power for five years, have five buildings, covering six and one-half acres of ground. This is one of the producer plants in the Metropolitan District which operates on bituminous coal, Loomis-Pettibone suction producers being used. Mr. Hausman, the superintendent, escorted the author through the plant.

The gases from the producers are passed through a vertical boiler before going into the scrubber and dryer. This boiler generates 80-lb. steam pressure, which operates the blower engine, pumping the gas to the outdoor holders. The same producers make water gas and producer gas alternately every few minutes. The water gas is used in the furnace of the forge shop.

Before installing the gas producer plant the Atha Company spent $20.00 per day for coal for the 42 furnaces in the forge room. With the gas producer plant they burn less than eight tons of coal in a 12-hour day, which displaces the old method of heating in the forge room and also gives them about 500 h. p. of Westinghouse engines direct connected to dynamos.

The Hooton Cocoa & Chocolate Co., Newark, N. J., have for five years operated a Fairbanks-Morse producer and gas engine. This is one of the cleanest, coolest, odorless and best appearing plants which the writer has seen. High ceilings, good light, and exquisite cleanliness contribute to the result. One first-class mechanic runs it with the assistance for a few hours daily of a low-priced helper. G. B. Griffith is in charge of the producer engine and dynamo. F. H. Sterner is the steam and refrigerating engineer of the factory. Mr. Griffith states that the repairs on the producer plant in three years have amounted to about $100.00.

A decided novelty in this plant is that the producer apparatus and piping were all painted with aluminum paint, adding to the lightness of the room and establishing a standard of cleanliness throughout. The operator also designed a novel ash pan under the cleaning door with an apron shaped to the curvature of the producer, which prevents the dust and ashes from getting on the floor during the process of pulling the fires. This pan has handles at either end, making it portable and permits the ashes to be entirely removed from the building with ease after each cleaning process.

The Hooten Company also has a belted steam engine not in use. They purchase alternating current electricity from the street for running part of the factory and generate direct current in their gas producer plant.

Mr. George F. Heinrichs, who operates a meat market in Manhattan Island, New York, 120x150 ft., part three and part two stories in height and irregular in shape, has operated with producer gas for five years. This is a quiet running plant with no smell or vibration, and is one of the best plants from the standpoint of operation. Mr. J. Ruf is chief engineer. The Hill-Hupfel suction producer and Struthers-Wells gas engine are used, direct connected to generators. Mr. Ruf thinks that the manufacturers over-rate the producer and also over-rate the engines.

The Auto Press Co., College Point, Long Island, have a factory 60x400 ft., three stories high. Their producer power plant is in the fifth year of service and runs five days per week, nine hours per day. They have had one shut-down due to careless engineer and since inspection have reported more trouble. The engine is belt-connected to the load.

Plants in Fourth Year of Service. Winelander & Jackson, who make steel lined brass pipe for beds, etc., have a factory 200x100 ft., one story high, in Brooklyn. The engine is located in a pit at the center of the shop and is belted to the shafting and to a small motor used as a dynamo and furnishing all electric light and power. The engine runs quietly and emits no smell whatever. The tool maker takes complete charge of it and a night watchman cleans the fires at night and charges in the morning. For a 12-hour run they use 1000 lb. of pea coal and for a 24-hour run they use 1500 lb. of pea coal. Mr. E. Ebke is the superintendent. This plant is a pronounced success and has been in operation since July, 1911. A Smith producer and Nash engine are used, with belted connection to the load.

The Acme Electric Garage, 410 East 32nd Street, Manhattan Island, has been enlarged three times since it was installed four years ago. The building in which the garage is located is a nine-story loft building. Wood producers and two Bruce-Macbeth engines, direct connected to generators. When inspected the plant was being increased in size—close to 600 h. p.

Plants in Third Year of Service. The Erie Railroad Co. had a gas producer plant in North Paterson, N. J., which was later removed to Croxton, N. J. This gas engine was belted to the shaft and ran satisfactorily with three or four shut-downs in three years. The master car builder stated, "A pail of coal now and then, just like firing a base burner parlor stove." This plant was removed from North Paterson because it was too small for the work. It is belt connected to the load.

Plants in Second Year of Service. The Mergenthaler Lintoype Co., Brooklyn, N. Y., have a satisfactory working outfit consisting of a Smith producer and Rathbun-Jones engine. This was one of the plants where the producer was located outdoors. Above it is an electric hoist for charging, which is covered by an ordinary corrugated roof to protect it from the rain. The gas engine is working in parallel with four steam units, all delivering electricity for the operation of the factory. R. J. Meadows is the chief engineer.

The American Cotton Oil Co., Guttenberg, N. J., have operated a plant for two years, consisting of Smith producer and Allis-Chalmers engines, direct connected. They have recently changed from pea coal to buckwheat coal.

Castle's Ice Cream Co., Newark, N. J., have a producer plant in its second year of service. They also have a steam plant. The gas power plant consists of a Smith producer and Nash engine, direct connected to a dynamo.

Plant in First Year of Service. L. O. Koven Brothers, makers of stoves, ranges, etc., in Jersey City, are operating two Loomis-Pettibone suction gas producers for bituminous coal and one Westinghouse engine, direct connected.

Experimental Plants. Standard Motor Construction Co., Jersey City, installed a gas producer plant more or less as an experimental proposition, with a view to adapting gas producers to marine work. The experiment was not a success. The Loomis-Pettibone producers were in use for five years and are now for sale.

Stevens Institute, at Hoboken, N. J., have an Otto producer and gas engine, and also a Nash and a Mietz & Weiss gas engine, which are used for instruction purposes. These are direct connected.

Gas Producer Plants for Baking. The Cork Insulation Co., Jersey City, have two Smith producers generating gas to heat the ovens for baking cork insulating block. They have done considerable experimenting in the mixtures between pea and buckwheat in order to get a stable fire with free burning qualities, which will allow them to force the producers above their rated capacity.

The Hyatt Roller Bearing Co., Harrison, N. J., have 500 h. p. Westinghouse producers used for making gas for furnaces. They use bituminous coal and have the down and up draft system.

The Crucible Steel Works at Harrison, N. J., use two Hughes gas producers for open hearth steel process and they are reported very satisfactory.

Defunct Gas Producer Power Plants. Mr. C. E. Hertlein had no success with gas producers in his factory in the Bronx, New York City. They bought one plant in 1907 and in 1909 they bought another. Although the expert from the manufacturer tried to teach their steam engineer, it was unsuccessful. This was partly due to interruptions to service and partly due to the fact that live steam was required in their dye house. They found that exhaust steam from steam engines was just as good as boiler steam, and that with the steam engine running for making electricity their coal bill was about the same as when the gas producer plant was running. He now generates his power by steam engine.

The Cameron Machine Co., Brooklyn, N. Y., installed in 1907, a second-hand belted gasoline engine. The writer was informed that it was later changed to a gas engine for street gas and then was again altered to a gas engine for producer gas. They found it preferable to buy their electricity from the Edison Company.

The New Jersey Adamant Mfg. Co., Harrison, N. J., used a producer for three years and after changing the line of manufacturing sold the producer plant. They state that it worked satisfactorily.

The Harper Brick Co., Harrison, N. J., used a plant for two years but later sold it. They now use a steam engine for hoisting at the dock as the service is intermittent.

The Newark Spring Mattress Co., Newark, N. J., laugh at the suggestion of using gas producer power. They found it generally unreliable and said that all the experts in New Jersey couldn't make their plant run. This is the plant sold to Leiman Brothers machine shop, where it has operated with entire satisfaction for over three years. Apparently the success of a gas producer plant depends largely upon its environment, because here was a failure converted into an unqualified success, apparently by virtue of supervision.

The Public Service Corporation replaced the Newark Spring Mattress Co. with their electric service at a rate "much less than three cents." Mr. Odell, of the Mattress Co., stated, "I have nothing to remark except that we are perfectly satisfied with the arrangement."

The Adriance Machine Co., Brooklyn, N. Y., purchased a gas producer plant second-hand, but never unpacked it from the boxes, inasmuch as they completed satisfactory arrangements with the Edison Co.

The Manhattan Screw & Stamping Co., when inspected, had a gas producer plant with 75 kw. dynamo which is for sale. The firm retired from business.

As far as the writer can see, the failures of gas producer power plants are approximately 21 per cent of those which have been installed in New York City. Information from another source indicates that among the independent electric plants using steam in Manhattan Island, about 10 per cent have been shut down and replaced with Edison service.

It is a question as to whether the percentage of mortality for gas producer power plants is not low when we consider the comparatively recent development of internal combustion engines and gas producer as compared with the history of the development of steam.

The mortality rate for all the gas producer plants of which the writer has a record, indicates that 17 per cent of the number of these in New York and the Metropoiltan District have been discontinued. One of these cases was where the firm owning it retired from business.

The writer wishes to acknowledge his indebtedness to Messrs. Frank A. Pattison, Charles E. Pattison and D. D. Kimball, Consulting Engineers, whose generous and unselfish help made possible the collection of this information.

DISCUSSION

JOHN H. NORRIS: In connection with the National Meter Co.'s plant, data from which is given in Table 1, this plant is only charged once daily. The number of charges daily depends on the magazine of the producer. If a producer has a magazine which works exactly as a base burner stove, it can be charged once every ten or eleven hours, and if run twenty-four hours, it needs charging only twice a day.

To clear up a point in regard to the consumption for a 10-hr. and a 24-hr. load, the question of consumption on a stand-over load depends entirely on the operator. If he leaves too large an opening on his purge pipe, he will burn up more coal on the stand-over period than he would if the stop valve is closed down so as to just keep the fire in condition. The difference in ratio between the consumption on a 10 or 12-hr. load and a 24-hr. load is the difference in the amount of coal the operator burns up in the stand-over period. The ordinary consumption of a good producer is approximately 1.1 lb. per h. p.-hr. with coal running at 12,000 b. t. u. per lb.

In regard to the Auto Press Co's plant, I am interested in the data from that, as I laid out the plant, built and installed it. While they were operating they had practically no trouble at all, but they did get a poor man in the engine room and he practically wrecked the engine through inattention.

The plant of which Mr. Thurston is engineer has been in use longer than stated by Mr. Ripley. It is within my personal knowledge that that plant was shut up at half-past six at night and ran through till seven o'clock the next morning day after day for 365 days in the year, and only once in six years did the plant stop through the closed period. I do not know of a single power plant, unless it is an electric motor, that can be left to run itself that way.

This paper is restricted to the Metropolitan district. We know that putting a gas plant, particularly a producer gas plant, into operation in the Metropolitan district, is one of considerable difficulty, owing to the restrictions imposed by the civic officials and the Underwriters' Association. These

two elements prevent the use of the producer gas plant in what might be called the Metropolitan districts.

HORACE G. H. TARR: For the last few years R. D. Wood & Co., with which concern I am connected, has gone into the field of larger producers than are discussed in the paper. I had the pleasure of reading a paper before the American Water Works Association perhaps five years ago at the meeting in Toronto, when I advocated a greater economy in the installation and operation of small waterworks plants. At that time I cited very strongly a plant we had built at Poughkeepsie. Anyone familiar with that plant will remember that the pumping cost has been brought down about 70 per cent. The plant has been running now for eight or ten years, there has never been any accident, and the plant has been running as smoothly as possible.

In observing the pumping plants of the country, gas power plants, very closely in the last ten years, I have found that the greatest difficulty is in the operation of them. A gas power plant is not wholly fool-proof. The difficulty with most of the gas plants in this country is just as the author has said—the man who cleans up, scrubs the floors, works in the shop, and does the handy work generally, is put in charge of the gas plant. Many times trouble is experienced with plants simply because they are not operated properly. They are operated, in most cases, by mechanics and not by engineers.

Up to a certain size, a gas power plant is beyond any question just as reliable as an automobile if it is properly built and properly run.

In the larger installations of gas engines, 500 or 600 h. p., we cannot figure out the costs as closely as we would like to do. In our own plant, where we are melting 200 or 300 tons of metal a day, we have five 300 h. p. engines running the plant. What it costs to run the engines we do not know, for the reason we dry our molds and do everything of that character with gas. In one foundry, we run three engines of 300 h. p. and in another foundry we run two engines of 300 h. p. We cannot tell our fuel costs. We have been running these engines for eight or ten years, and we never had a single breakdown that was of any consequence. A cutting-off of power would be a serious thing, and would cost us a good deal of money.

In our work, we must have something that is reliable, and our experience has proven to our satisfaction the absolute reliability of the gas engine. As to the relative cost, when you come to put in a large gas engine installation, you will find it will cost you about $100 per h. p. A steam turbine installation will cost you a good deal less than half that. With several of our large installations, we are getting a horsepower-hour from one pound of coal, but the steam turbine, which costs half as much, will get down to less than 2 lb. of coal per h. p.-hr. These are the conditions in the gas producer business in the larger sizes. They do not apply to the small installations.

In a broad general way, Table 2 is exceedingly interesting, because it bears out almost exactly our own statistics. This remark applies to 500 h. p. installations.

It is no more fair to make a comparison of the gas plants of the present day with those of the past than to make a comparison between the automobiles now made with those of a few years ago. If a comparison is made of the plants that have been installed within the last two or three years, the characteristics of the plant can be taken and a correct opinion formed as to whether or not a small installation, 500 h. p. or below, should be a gas or steam plant.

There have been some failures in plants in the last four or five years. In one case of failure of a gas plant in Florida, I found it was due to the fact that they could not get any cold water. The water used for cooling was absolutely warm, above 70 or 80 deg. fahr. The water was drawn from a swamp, which was subjected to the rays of the sun, and serious difficulties were caused by it, showing that all conditions must be considered. If the latter is done, there is no question but that the gas plant is more, or quite as economical, as the steam plant.

E. RATHBUN: I know, to some extent, the amount of patience required to get answers out of power plant owners, and the author deserves a great deal of credit for what he has accomplished.

We have a very interesting producer gas pumping station in Toledo where our factories are situated. All the city water goes through the plant; it is the filtering plant, and there are three 15,000,000 gal. direct-connected 2-stage Wood & Co. pumps, and also four 500 h. p. producers, the total capacity of the engines being about 2,000 h. p. There is practically no reservoir capacity. The plant has been in operation about five years and has never been without water. They have a spare unit, and keep the pumps running all the while, that is, the low service station. The water is lifted by the pumps and put through the filter plant—the pumps are in a pit 45 ft. deep below the river level—and the water then gravitates to the high pressure city service, which is steam-operated, and, everything considered, the producer plant pumps the water for exactly half what the steam-operated plant does.

In regard to the list of plants in Table 1, one of the plants in Bayonne, N. J., now shut down, is missing. The original plant there consisted of an 80 h. p. two-cylinder engine, and a 100 h. p. three-cylinder engine, which were operated by the Southern Cotton Oil Co. This company has other plants, to the extent of four or five, of the same make, so that they are familiar with the apparatus. It seems the shut-down in this case was a matter of faulty attendance entirely.

The plant at Bayonne was in the same category as all the other plants, and it should have been as good as the J. M. Horton Ice Cream Co. plant or the Mergenthaler Linotype Co. plant, or any of the other plants,—there is no reason why they should not all be the same. There was the same chance at Bayonne for securing the proper kind of labor, for securing the proper coal and everything else, but the plant was not successful. It was shut down, and probably the reason was not so much on account of the difficulties of running the plant, but because the costs of repairs were high.

For comparison, consider the J. M. Horton Ice Cream Co. plant, the Swift & Co. plant, and the plant at Bayonne. The J. M. Horton Co. report their repairs not higher than they should be. The Swift & Co. plant report their repairs higher than they should be, and the Bayonne plant is shut down, apparently largely on account of excessive repairs. The ratio of the costs of repairs on these

plants in five years is as follows: J. M. Horton Ice Cream Co., 1, Swift & Co., 3, and the Bayonne plant, 10.

On the basis of h. p. years, the cost of repairs of the J. M. Horton Co. plant was about 30 cents per h. p. per year; the Swift & Co. plant, $2 per h. p. per year from the time the plant had been in operation, which was excessive; and the plant in Bayonne, $4 per h. p. per year. I went over to the Bayonne plant once, and found the small engine was running with the exhaust wide open and the governor down on the engine. That was one reason why this plant shut down.

There are many interesting points in this paper. It has been brought out here that Mr. Ripley has made a point of dealing with the small plant, not particularly, possibly, but in his report he has called attention to the small plant. If you look at the plants which have been thrown out, it is always the smaller plants.

As you get into the larger plants it is true that it is very much more difficult to get reliable information. When we stop and try to figure out and go over our list of plants and get some accurate information about something, as close as we are in touch with our own plants, we find that there are very few plants in connection with which we can get absolutely reliable information. True, the Horton Ice Cream Co. is one of the plants which keep the most accurate information of any we have on our books. There are plants where they have wattmeters and get the coal consumption per kw.-hr. Perhaps in the same plant they are doing some pumping, however, and drawing gas for that, so their data is not reliable. Some plants do not keep any records whatever, and they are liable to guess at the coal consumption and give erroneous results.

One point which has not been brought out in this discussion is that the oldest producer is only sixteen years old; that sixteen years practically represents the total development of the art, and it is quite a short time. It must also be remembered that this paper covers only a very limited area, and it is a feature of the gas producer business, as of all others, that it shifts from one part of the country to the other. In 1906 and 1907, within an area of 200 miles of New York City, we put in about 3,000 h. p. within about two years, and yet during the past year we had just one inquiry from Connecticut. Connecticut, logically, should be the best producer gas district in the whole country—there is good coal available there, and everything tends to good operation.

As regards later developments, it happens in this district there are no raw water ice plants, and in the last year and a half we have put in six raw water ice plants. That is a new development, and is particularly adapted to producer gas power plants. We have put in about 1500 to 2000 h. p. in the last year and a half on raw water ice plants. The development of the raw water ice business is also directly connected with compressing. In many of the compressing plants, being direct-connected to the engine, they drop the speed 15 per cent and increase the compressor speed almost 300 per cent, so that while it is true that the business has not been so active in this district, still it has been more active in other districts. Table 1 is not, of course, absolutely up to date; there have been new installations since its compilation, probably, not less than 1,000 h. p. which is not included in the table.

William T. Price: The gas producer plants which have been put in in the past three or four years, which Captain Tarr has referred to, are much superior to those put in originally. It seems that the very best location for the producer gas plant is the place where there is, first, a steady load; second, good coal; third, where pea coal can be obtained. A great many producer plants are started up and it is recommended that they operate on buckwheat coal. A great number of the plants mentioned in this paper are operating on pea coal, in fact, nearly all of them. The last requirement, and most important of all, is that a good man be placed in charge of the station.

Mr. Ripley referred to one plant, which was an utter failure in its first location which, when put in a new location, was a pronounced success. That is quite common with the internal combustion engine, and the problems that come with the internal combustion engine plant of any kind seem to be about 80 per cent operating problems.

A good many comparisons are drawn in the paper between the producer gas engine and the steam engine. A few comparisons with oil engines might be of interest.

The power gas engine plant is guaranteed to operate under certain fuel consumption per h. p.-hr., but in a great many cases the fuel consumption, taken over a long period, is considerably different from the guaranteed fuel consumption. That is because, as Captain Tarr pointed out, the economy depends principally on skill in operating. The oil engine, on the other hand, seems to show practically the same economy over long periods of operation that it does under test conditions.

The early oil engines which were put out, of course, were not as perfect as those which are being made today, and troubles were experienced. It seems, though, that the oil engine of the present, and of the future, compares very well with the gas engine of the present, but this difference exists: that the oil engine is a complete power plant in itself, whereas with the gas engine it is necessary to have certain fuel-making equipments. In the oil engine the fuel comes in a condition ready to use, but with the power gas engine the fuel must be prepared. Therefore, it seems true that, in the present and in the future, whatever troubles come with the producer plant should be eliminated in the oil engine plant. The relative fuel economy depends on location.

There are places where coal is very cheap and oil expensive, and in those locations the producer gas plant finds a good field and the oil engine is handicapped. All down this Atlantic seaboard, however, in the case of plants of 300 h. p. and downward, the difference in fuel consumption is very slight—sometimes it is in favor of the oil engine and sometimes in favor of the producer plant, and we may say that it is more generally in favor of the producer plant, showing that the fuel consumption with the producer plant is slightly less than in the case of the oil engine plant along the Atlantic seaboard. Of course, in the West and Southwest, coal is very expensive, and coal producers have never proven successful, so the oil engine finds a broad field there.

Another advantage of the oil engine plant over the producer gas engine plant is the saving in the space occupied. Mr. Ripley has given an intensely interesting study of data, and with close attention considerable profit should be derived from it.

INDUSTRIAL SAFETY AND PRINCIPLES OF MANAGEMENT

BY W. P. BARBA, PHILADELPHIA, PA.

Member of the Society

THE matter of accident prevention has come to be considered as a point vital to the success of any business—through the operation of reasons, economic, humanitarian and sociological. Only a few years ago, say ten years, little was heard in this country of more than desultory efforts to minimize the waste of human effort through accidents. Now the slogan *Safety First* has been given widespread currency, and has lately been improved by coupling with it another, without which the first is really of little value, hence we now hear *Safety First—Safety Always*.

It requires no detailed presentation to make manifest the waste to the world of productive power through the suspension from their daily labor of men injured therein, of the consumption of materials without the corresponding production which normally would result therefrom—of the real suffering, both of the injured man and those dependent upon him, or of the investment laid aside and idle with every man injured. As part of a study of the principles of management (which should accompany the technical education of every man called to work amongst his fellows) much too little attention is given to the subject of methods of employing labor, both trained and untrained, and too little weight is laid upon the cost of training *any* new employee into the duties for which he is hired. Few realize that each man hired into a plant is the subject of investment for quite a time before he is sufficiently trained to the work he is to perform as to return a profit. It is probable that a study of the subject would produce a figure of $150.00 average of investment in each man before he becomes productive.

So when true principles of management are but little understood and rarely taught, it is customary to witness many discharges as corrective of offenses which are perhaps trivial at best, but which discharges in any case only act as correctives for the benefit of the employer with whom the discharged workman may next engage for employment. A better way, for instance, is to call up the man, convict him to his own satisfaction and yours, of the wrongdoing in question, and then and there apply the punishment which should correct the offense, using means which will inure to the benefit of the employee as well as the employer. This can be effected by lay-off or fine; discharge should be rare, and only for major offenses. Fines should be used most often in preference to either of the other more usual means. Fines should be laid with great care for the proper amount needed to effect the corrective, and a relatively small sum usually is sufficient. In no case should fines accrue to the benefit of the company, this having a very disturbing effect upon the value of the corrective, but fines in all cases, both for spoiled work and for discipline, should be converted into a fund for the benefit of the whole body of workers. Some mutual benefit plan, such as is now happily established in most up-to-date works, should receive the results of all fines. The result is then doubly beneficial, and has a balmy effect which removes all soreness and sense of *personal* injury from the transaction.

Presented at the Philadelphia local section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, on Nov. 23, 1915.

Referring again to the loss of investment from removal of trained men from production by discharge, let us also look at this loss through *physical* injury, and especially those arising from preventable causes. It is, of course, plain that the investment loss through injury can become a permanent loss of producing power, the loss of investment causing the employer to suffer, and the loss of producing power causing the injured man to suffer permanently, as well as through the physical pain he bears, meanwhile; his producing power and income reduced or gone, his expenses continue even on a reduced scale, his mental condition is much disturbed and he wonders what can be done, and so the rapid but all too slow growth of the safety movement, the liability and compensation laws, the preventive measures, but most powerful of all, and as yet but little developed, the education of every person engaged or even interested in industry, to the end that all preventives be used both *without* and *within* the person of the operator subject to injury.

Figures compiled during a term of years point most strongly to the lack of proper education as the prime cause of injury—loss of productive power, and all the attendants of this condition. Hence, industrial safety and sound principles of management are without doubt most closely bound together, and cannot with success be considered apart. Commissioner John Price Jackson, of the Department of Labor and Industry of Pennsylvania, has shown in dollars and cents just what the large number of accidents that are occurring in the industries of the State, are costing the workers. He has not figured what they cost the employers.

During 1914 accidents cost employers in a score or more of the larger industries in Pennsylvania the sum of $1,048,503.96, which total is computed on the daily wage. There were 38,126 men thrown out of work and each of these men lost on the average $27.50. The accidents from which Commissioner Jackson has computed the figures do not include those reported to the State Department of Mines or the Public Service Commission. The report shows that about one man in every 28 lost time because of accidents, as there were 1,086,508 employees in the industries from which statistics were gathered. The average daily wage was $2.45 and the total number of working days lost was 426,824.

This brief report gives one an idea of the extent to which accident prevention may go, the aggregate for this State only being so large as to appall one, and still does not include mining risks that are notoriously great. Indeed, most of the opposition which was disclosed in an organized way to the enactment of a workmen's compensation act has been from the smaller operators of mines, whose whole capital could be annihilated by the liabilities arising from one accident on a small property.

From the operation of these causes, motives and products alone, there has within the last eight years, come into being a general safety movement, looking more toward the possibilities of prevention than ever before. Out of all the upward striving of humanity toward better things and better conditions comes a new principle: namely, that a trade should bear the charges and costs of its casualties, and from

this, the employers' liability and workmen's compensation movements have gained much force. Rarely has there come before the public a movement involving so-called capital and labor, but in reality employer and employed, which has met with such complete support from both sides. But there *are* no "sides"—the interests of *all* employed in the world's productive work are entirely identical. To enlarge upon this thought, for it is one of the links attached to the title of this paper, these two, together with their many links, are inseparable—in practical everyday work, just like a graphically expressed formula in organic chemistry.

It will have been noticed from these prefatory remarks that this connection is quite clear. One who is charged by his owners with operating a large manufacturing plant has as his first practical concern, the securing and retaining, as well as maintaining in good efficient condition, a well satisfied body of workmen, contented, well paid, and their physical condition well in hand.

After this the managing executive may take up his financing, his raw materials, manufacturing methods, selling organization, etc., but no manufacturer can possibly succeed without this satisfied body of operating workmen—fellow employees as just outlined—to secure and maintain this condition is a prerequisite to any further success.

The economic as well as the social side of this problem must be just as carefully looked after, now that Pennsylvania has a workmen's compensation act, the twenty-fourth in the United States, which country followed quite a long way behind both Germany and England. No longer will industrial safety be thought a fad, no longer will the courts be filled with cases crying for just relief, no more will the cheap lawyer haunt the hospitals to prey vulture-like upon the unfortunate. Each trade is to bear its share of the cost of its casualties, and the ultimate consumer will pay the bill. All this is exactly as it should be, the only danger lying in the chance, a real danger too, of the whole game being absorbed into some form of political spoils, which God forbid.

Much is being said and printed about foreign trade, foreign competition, foreign methods, and many have objected that the securing of this foreign trade in normal times was difficult, due to the difference in labor conditions, rates of pay, etc. It is very interesting to note that in 1885, Germany established compensation measures, followed by England in 1891, so that our trade abroad is not menaced by the adoption here of these plans for workmen's compensation. On the contrary, we have lagged so far behind these stiff competitors, in these particular matters, as to cause unfavorable criticism of us by those who know.

Now when such compensation acts are generally in force, each employer will be placed automatically on piece work to make his plant *safe;* and the penalty for failure to achieve safety of equipment will be very great. There are, however, other features in the case: present and proposed laws provide greater compensation for a man with a family than a lone bachelor without dependents, some laws providing compensation for the grandfather of a man injured, when dependent. The natural result will be to select for employment men who offer the lowest risk, both as to compensation penalties and as to physical condition of the applicant, which condition exactly reflects chances of injury, and consequently, the rate of risk. The compulsory insurance laws of Great Britain, placed in operation in 1912, immediately resulted in selection of employees whose rate of risk was the lowest, and thousands of perfectly good workpeople were turned adrift for this reason.

This is one of the consequential results our legislators and agitators should consider most carefully. There will inevitably result, a careful selection of the best insurance risks, and defectives of all kinds will find it most difficult to obtain and retain employment. A defective in this sense may be a man physically unfit, incipient hernia, a tendency to joint dislocation, etc. He may be defective in the sense that he just cannot keep out of trouble, and this kind of a man soon cannot keep himself in a job. He will be *selected* to be always out of a job, until he learns to *think* enough to keep himself from unnecessary injury. Study of the figures showing frequency of accident to the individual no matter where working, inevitably searches out such men, and then the employer must move the man, either to another job or else *out,* both ways meaning a loss of investment, production and earning power. Again education, both of the man and his employer, most necessarily his immediate foreman, is needed and just how best to supply the lack is a task worthy the best mind in your employ.

The works with which the author is intimately associated, has for years made a careful physical examination of each man offering for employment, having in mind his condition with reference to health, present and potential, his record as to previous injuries and their results, his eyesight, hearing and whatever condition will affect his value both as an individual and as affecting his fellow workmen.

At one works there were offered for employment, practically hired, then turned over to the physicians for this examination 2,569 men during the year 1913; of these 391, or 20 per cent were rejected for various reasons. Of these 391 rejected, 285, or 75 per cent, were rejected for venereal diseases and consequences, it being deemed most unsafe to turn loose a man possibly syphilitic amongst presumably clean fellow workers. Of course, a man may pass inspection upon employment, and then find his health go down. He may become the subject of venereal disorder, or some other form of communicable disease. The answer for this is the growing need for periodical examination of each individual worker, and his elimination when his risk becomes too great. This periodical examination of employees has been undertaken to much too small an extent, and needs attention and developing. The benefits are numerous, the first and chief being the aid and assistance to full recovery, and checking in advance of disease which a man unconsciously fights off until he drops—mastered. Beaten by exposure to a blizzard or heavy storm when in a reduced condition, many a good man is lost, who, by a regular, even though cursory, examination might have been saved through timely catching, checking and conquering, through advice and aid, of an ailment creeping up on a man almost without his knowledge of anything going wrong. In this connection arises the demand, a just one, for some form of insurance, preferably mutual, and upon a sliding scale, according to the risk offered by each man. This is but one of the many problems each executive is going to face in the future handling of employees' matters.

When a man is hired, he should be taken to his foreman for careful instruction in his duties, its dangers and their safeguards pointed out, and every effort made to prevent

the new employee from becoming worse than a normal risk. As one concrete illustration of this, in a certain large works much fuel oil is used for heating purposes, and a comprehensive system of storage and distribution is installed. Leakage is impossible to entirely prevent, and numerous explosions and small fires have occurred. It is necessary at times to descend into the pits in which the apparatus is placed, and the explosive fumes of oil and air are frequently present; steam pipes (not air—because of the danger of air) are rigged in all such places and at stated intervals the steam is sent through these chambers entirely and safely displacing all noxious gases.

Again, the burners for fuel oil are merely a combination of jets and valves—some of the jets embodying the injector principle. Each man who is called upon to work with this apparatus is taken into the bureau of Safety First by his foreman, and with the safety engineer (a high priced executive) is taken through a course in his particular oil burning apparatus. The collected unit is there, it is disassembled and reassembled by the man, and a partly cut-out section is shown, so that all the functions of the system are fully understood by the workman. Since the introduction of this system of instruction, the number of burns and fires from ignorant handling has been very much reduced. It is impossible, however, entirely to eliminate the accidents from careless handling. Here, as elsewhere, the adage "Familiarity breeds contempt" is true, and it would be easy to multiply concrete illustrations of this statement.

In 1907, in a nearby large works, the safety movement was given a real start, by the appointment of a safety officer, whose whole duty was to report hazardous conditions of plant and equipment and see that the conditions were corrected. It has lately been more generally recognized as the function of the factory inspector of the State to keep every manufacturing establishment in a safe condition, so far as equipment, etc., is concerned. The present incumbent in Pennsylvania, Dr. John Price Jackson, has given real value to this function for the first time, but even he, up-to-date and progressive as he is, recognizes that the correct way is to make each factory safe automatically by having liability laws which properly penalize the lax employers.

The attempt of 1907 to effect safety of equipment by the appointment of a safety officer and his staff, in the works mentioned, was soon superseded by a plan to make the worker himself feel his share of the responsibility, and a committee of 70 men was chosen from among the employees, there being upward of 5,000 employees. These men were always on duty while regularly working and seven of them were chosen each week and with the safety engineer gave up a whole day in the company's time and pay to actual examination of conditions of plant and equipment. Their recommendations were given priority by heads of departments and the works were soon found in such good physical shape that the committees had little or nothing more to report.

The number of accidents was, of course, reduced, but not to a point which was thought commensurate with the efforts put forth. During all of this time (five years) careful study and analysis was given the daily accident reports, with the result that they soon segregated into three groups:

1. Hazards of occupation
2. Hazards due to faulty equipment
3. Hazards due to personal carelessness and disregard of safety appliances.

These regularly occurred in almost unchanging proportions, even though the sum total went steadily downward:

The first class—Hazards of occupation, 24 per cent.

The second—Faulty equipment, 3 per cent.

The third—Carelessness and neglect, 73 per cent.

This large proportion, 73 per cent, is purely a result of the operation of the personal equation, and, at once suggested itself as the point of attack.

To meet this a total change of programme was inaugurated. The plant was divided into seventeen distinct units or geographical districts and a committee of three was appointed in each for a term of two months. A datum line for each district was established from history which showed the frequency of accidents in each district. The figures were worked out in units per one hundred men employed for the period of two months, thus affording easy comparison.

The task set was for each district to equal or beat its previous record. No district was set against another, its record being wholly within itself. This is a vital point. Each sixty days' record is merged into the previous total and thus a new record automatically set. For a committee which equalled or beat its district record during the committee's sixty-day term, there was established for each man a cash prize of a ten dollar gold piece, or $30.00 for each winning district each sixty days (incidentally the amount thus paid during the year 1914 was $3,200.00, and no sum was ever more cheerfully paid out). In addition, the committee which made the greatest improvement upon its own record was, each period, granted a double prize, or $20.00 to each of the three men.

The experience of the first year was that out of the seventeen districts there were paid prizes all the way from four up to sixteen districts, the four being midway in the year, and the treatment applied by the management when this low score occurred, brough the score right up, so that at the last period fourteen sets of prizes were paid. The personnel of these committees is changed each period so that the experience gained is accumulated by a large number of men.

The treatment in this case was simply for the general manager to talk to the assembly of the men later referred to, and point out, from knowledge of the accidents occurring during the period when low scores were made, how greater vigilance, less laxness, more attention to the men seen to take hazards carelessly, would result in better scores, more gold pieces, less suffering, to risk of which each of the whole number of employees is subject, whenever vigilance in these particulars is relaxed.

There is also a collateral advantage which is a large part of the value of this new scheme. The management hires a large and convenient hall for a meeting place, provides cigars and light refreshments, invites all the men the hall will contain (about 400) and makes a public occasion of the presenting of the prizes. A free discussion of methods and experience is had, and from 8 o'clock to 9:30 an evening is spent which is most profitable in every way. Stimulation is given the safety movement, the managers are all there, and a great feeling of the community of interest of all concerned is engendered. The spirit of full coöperation is established and fostered, a better and closer acquaintance is had on all sides, and the whole effect is most beneficial.

The net result in figures is curious and interesting. By an accident is meant the state requirement or definition—that a man is away from his work more than two days. The number of accidents during the year just closed was reduced by 59 per cent, the three above classes being represented by 26.8 per cent, 2.23 per cent and 71 per cent, clearly showing that there is still more work to be done in fully bringing home to the individual his personal share in the responsibility for his injury.

This responsibility is going to be more closely brought home under compensation acts, since it will mean the elimination of men who are thus injured through their own fault too frequently; these men will be compelled to seek other employment. It then becomes a nice point of judgment for the management to determine whether its investment in such a man, i. e., his trained capacity for his work, is a sufficient offset against his increased risk, due to his propensity for acquiring injuries to an undue degree. Some of the compensation laws refuse a man any payment if it be shown that he was injured by *his own act* for the purpose of going on the benefit list. This provision and the one denying benefit for the first *fourteen days* are about the only safeguards the employer has against unjust claims for payments.

Reverting to the system suggested of avoiding discharge losses through conviction and fines, the proper channel for restoring fines upon delinquents to circulation through the whole mass of employees is—the recognized need of caring in some way for the reliable employees unavoidably injured slightly, and returning to work within the 14 days exemption period provided by recent compensation laws.

A fund could be provided, augmented by the company, especially so in the case of larger employers, this fund to be administered by a mixed board of employees, and a small measure of financial relief afforded the unfortunates who recover within 14 days. This period, designed by framers of the acts to prevent malingering, does not altogether effect this, and meanwhile works a real hardship on many worthy men whose needs are such that the uncompensated loss of *any* days becomes a matter of concern.

If ever there was a subject fit for Federal instead of State legislation, it is this one of liability and compensation. Fifty-eight States working each alone may produce such wide diversify of legislation as really to put neighboring States into competition for both manufacturers and for workmen. When John P. Neill was Federal Commissioner of Labor he worked assiduously to secure uniform State legislation on this subject because there were statutory difficulties in the way of a Federal act. This leaves it up to the several States where too often a subject of this magnitude is taken up by untrained and uninformed legislators who can, quite possibly, be swept into ill-considered action by a wave of hysterical outcry from the newspapers, professional labor leaders, and publicists who treat a situation academically and without close knowledge of the problem.

With especial reference to the Pennsylvania law just enacted, it is fine to recall how this law was prepared. Begun under Governor Tener by a board of broad expert business men, thrown out by the legislature of 1913, brought up again by a Governor fearless of criticsm, worked out modernly upon the basis of the original commission's draft, the Pennsylvania law is, generally speaking, satisfactory to all groups, and there is in it opportunity to coöperate fully, to protect those dependent upon their labor for daily bread, automatic incentive to clean, healthful surroundings, care in safeguarding equipment, and all concerned are compelled to do their utmost to achieve the blessed result desired.

Any employer, or rather fellow employee, who shall disregard the plain common sense demands for a legitimate, well considered scheme for automatic compensation for every injury not wilfully incurred, is not alive to his business, to his duties, to his men or to his stockholders, nor to his duties to the progress of humanity at large.

It is the speaker's firm conviction that the so-called *industrial unrest* is wholly preventable, is due chiefly to lack of understanding of the problem—lack of patient working in full coöperation with all concerned, and the result of following sound principles with policies based thereon is certain to prevent unrest such as has been all too frequent from just such causes.

The years in the immediate future will be largely occupied with the care and handling of just such problems as are here presented, and if anything said here gives a line to take hold of and follow, the author will be more than glad of the opportunity to discuss a matter so large as that of the subject presented. In pointing out the dangers of haste in enacting such legislation, all right thinking people are urged to work for the passage of such laws as will compel the lax, careless, or unwilling employers to secure the coöperation toward safety of workers whose livelihood, and lives, are in the hands of those who pay wages, and as before mentioned should find it a cheerful duty to work toward the securing through coöperative effort, of the maximum of safety, comfort and happiness among all grades of employees. Only thus will the work of the world be furthered. Only thus will there be removed from among us strife, discord, class distinction, unions and non-union, and there will surely come into industrial life, the big rewards which result from careful thought along lines which go to promote full coöperation amongst those called to do the work of the world.

SAN FRANCISCO MEETING

THE five papers presented at the two sessions of the September meeting of the Society held at San Francisco, September 16 and 17, in connection with the Panama-Pacific International Exposition and the International Engineering Congress, were published in the October and November issues of The Journal. In this issue is published the Discussion that followed the presentation of the papers. That upon the paper by G. L. Bayley, is of particular interest for its application to the varied construction problems at the Exposition, and that upon the paper by W. H. Adams, in view of the development of the Diesel engine on the Pacific Coast.

DISCUSSION OF PAPERS AT SAN FRANCISCO MEETING

PAPER BY G. L. BAYLEY

G. L. Bayley, in presenting his paper on the Engineering Features of the Panama-Pacific International Exposition, dwelt upon features of interest supplementing the text of his paper, as given in the following account:

Mr. Bayley, referring to the planning of construction methods and preparing estimates and load curves for the Panama-Pacific International Exposition, said they naturally wanted to be guided by data relative to previous expositions and had searches made for such data, even in the Congressional Library. To their astonishment, little real information was available. Such an important item as the maximum load at the St. Louis Expositon was finally found in Engineering (London). The load was 13,500 kw. All the various reports of that exposition gave full descriptions of the great power load, how many thousand horse power was being utilized, etc., but the maximum load and diversity factor, or any other elements which would have been a guide in their case, were not available. It is impossible from any reports to find the amount of water used at previous expositions; any records, where they exist, are not available.

When they started in to build the Panama-Pacific International Exposition, Mr. Bayley said that if they had only known half as much as they know now they could have saved many thousands of dollars. Now that they have collected a great deal of information, much of which is of real value, they intend putting it on file in the Engineering Society's Library in New York so that it will be available in the future.

The area occupied by the main group of the Exposition palaces, which includes eight large buildings, was about 12 ft. under water when they started operations, Mr. Bayley said. So at the very inception of the work, they had a problem of considerable magnitude. The filling in was performed by the aid of suction dredgers, and in that connection they followed out a procedure which he did not think was unusual, although it has attracted some attention, that is, getting rid of the soft bottom by displacement of the heavier material. The discharge pipes were so located that the heavy sand kept forcing the ooze and mud ahead of it and out through the sluice gates. Occasionally, in order to stir up that material, they would run the dredgers without pumping any sand. The result has been a very solid compact fill, which, however, has been settling regularly as was expected. The large buildings were all placed on piling, and the amount of piling is somewhat tremendous. He conveyed some idea by saying that if the piles were all stood on end, they would form a column 125 miles long, and if one stops to consider the cost of driving 125 miles of piles, one realizes the initial work on hand.

Before starting the work of pile-driving, Mr. Bayley said a number of experiments were made to find out the load which would be permissible, and these experiments proved to be exceedingly valuable, not only from an engineering point of view in determining the amount of load that a pile would stand, but as to the exact length of cut-off of the various piles, so that when a contractor was called in to take a contract for piling, he knew exactly, within 6 inches almost, the length of piles over the area. In that way they obtained close bids, because the contractor knew that he could use piles of 35 or 40 ft. and so on, and he would not have a lot of other lengths cut off which could not be used.

They found, in driving the test piling, that the fill itself imposed a considerable load on the piles. One can realize that from the suction of the fill on the pile, and the fact that the fill was settling. A portion of the fill was over an existing sand bank, under which lay a stratum of clay. Following the standard procedure, they would have driven into that clay and probably have used a 40 ft. pile. They found by experiment that they could drive into about 12 ft. of sand but not puncture through it, and get practically the same bearing value with those piles. The result was that they used 12 ft. piles instead of 40 ft. If that were converted into thousands of dollars it would be a considerable amount, all of which indicates the advantage of proceeding with exact knowledge of the conditions as they exist, and which can only be determined by experiment; although they spent probably $6,000 in getting this information, it was well worth many times that amount.

Mr. Bayley then referred to the question of structural design of the Exposition, most of the structures being timber ones. In the last fifteen or twenty years very little advancement had been made in frame structures, because steel had supplanted the use of timber very largely, and frame structures have been mostly used only by sawmills and similar activities. In the instance of this Exposition, wood was by far the cheaper material to use, and in addition, could be gotten very readily, whereas there was an element of time in getting deliveries of steel. That knowledge which had been secured to engineering by the steel practice has been applied with rare intelligence to the design of the wooden structures of the Exposition. In the Machinery Building, for instance, there is some very interesting frame work. Shear pins are used effectively, and the enormous roof structure really seems to be very light.

Some very valuable data was secured by testing out full sized joints, Mr. Bayley said, and, strange as it may seem, with a shear pin made of a certain Hawaiian wood, a greater

strength was deleveloped in the joints than if the pin were made of solid steel. A technical paper has been written on this particular subject, and those who may be confronted with a problem in timber design might well consult this. With the exception of the Tower of Jewels and the Palace of Fine Arts, the buildings are all timber structures, and all are carried on pile foundations, except a certain one or two, which are on spread structures.

The Tower of Jewels is a most interesting example of engineering. This was built up as a pyramid, and as originally designed the tower was to contain the administration office and presented a very serious problem of construction. That idea was abandoned, however, and the weight of the steel was reduced by half; in other words, the tower was framed up for the usual load of floors, after the same type of construction that is used in office buildings. By adopting the pyramid form, and furring on the various platforms of timber, the cost of construction of the tower was considerably reduced.

Mr. Bayley pointed out that the Exposition is more or less of a dome city. Dome construction is somewhat unusual, and many interesting problems were solved in connection with the various domes that are at the Exposition. Doubtless, the most interesting dome is that of the Palace of Horticulture, which has the largest spherical dome in the world. It is 152 ft. in diameter and has a height of 185 ft. To show the difference in results that may be obtained by starting on different suppositions, one engineer designed that dome as a 3 in. arch; the depth of the ribs was 6 ft., and the angles used were six by six. Another engineer designed it as a through dome, with ribs 4 ft. deep, and angles four by four. Doubtless, the former engineer's calculations checked out all right, but by adopting the latter's figures, the dome was built with about half the amount of steel and is a perfectly rigid and stable structure.

The method of erecting this dome was to take two ribs, form them together on the ground and then hoist them. A gin pole was used in the centre to carry the ring and hold it up while a third rib was put in, when of course, the structure was comparatively stable. After that, one rib was put in at a time until the dome was completed. The methods used for putting up these domes were very interesting. Apparently, no two contractors agreed as to the best method, and many ingenious means were employed.

The method of dome framing was rather original, and the framing of the great half domes on the west side of the Palaces of Food Products and Education were very interesting examples. The Palace of Fine Arts is a building which is semicircular in plan, and, of course, had to be free from all columns; for that purpose the three-hinge steel arch construction was used.

At the start, Mr. Bayley said, rules were made governing all structural work; in these rules the allowable load stresses and other designing data were established, with the result that the designs were consistent throughout. In a work of this magnitude, it seemed very essential that each man's work should agree with the work done by every one else. In other words, consistency on the part of each individual designing engineer, in such assumptions as factors of safety and unit stresses was desirable. Not only did the Exposition have a large corps of designers of its own, but, owing to the press of work and the shortness of time, some outside engineers were employed and these received the same set of rules to govern their designs.

Regarding the sewer system, Mr. Bayley said there were no especially difficult problems there, except that they had to lay the sewers bearing in mind that the ground was settling, so that wherever they had connections from buildings, they had to be flexible connections, which called for a special design. At the State and Foreign sites, owing to the flat grade, and the Exposition grade being only a few feet above high water, it was necessary to put in some pumps, drain the sewage towards one central point and pump it to the Bay.

Under the head of transportation, Mr. Bayley said their greatest problem was that of handling lumber. It was really quite an inspiring sight there at times to see six or eight vessels all piling lumber down, but the large volume of work was well cared for by the simple method of using lumber trucks and horses.

Possibly no problem in connection with an exposition, Mr. Bayley said, is more serious than that of carrying on building construction and trying to maintain roads at the same time, and especially as so much work is usually done during the wet season. Of course, at San Francisco they worked all the year and very few days were lost. Plank roads were used throughout to great advantage and while probably $40,000 or more was spent for those planks, the expenditure was well justified, because they could very rapidly change a road in order to get material in for the various buildings.

The plank roads were further useful at the time they came to build the permanent roads. In constructing the permanent roads, they found a very satisfactory method to be to build half the road and pave it, in the meantime maintaining traffic over the other half by means of planks. Then as soon as the half was paved, they would move the planks onto the paved half and switch the traffic onto the planked side and build the other half of the permanent road.

Rigid traffic rules were necessary, Mr. Bayley said. Teams were obliged to come in at a certain point and go out at a certain point; otherwise there would have been a hopeless jumble. Those who have not seen the building of an exposition, he said, can hardly conceive the amount of pre-exposition traffic, particularly just before the opening day, when teams are coming in with exhibits. Exhibitors are habitually late, and they all come in at the last minute and work all day long and into the night making deliveries, and, unless a good scheme has been well thought out to cope with the situation, confusion is liable to reign.

The Exposition undertook to deliver exhibits directly on the exhibit space. This was quite a departure in exposition traffic, but one which has been very satisfactory to exhibitors. In previous instances, the railroad terminated at some point in the Expositon grounds and then the exhibitor had to make arrangements with some local concern to get his exhibits moved in. Here they made a terminal rate so that an exhibitor, say, in Philadelphia, could get from the Pennsylvania Railroad the exact cost of transporting his exhibit and delivering it right to his space in the building it was to occupy.

As they undertook that obligation, Mr. Bayley said it was essential that they make some arrangement to take care of the situation. They ran spur tracks into all the buildings, with unloading platforms and then made use of

the transveyor, which is a small truck with a mechanical arrangement for use in connection with special platforms, and with that they handled the situation without any congestion. In the same connection they had a number of storage battery industrial trucks and at times these were used to haul the transveyors. In the Machinery Building were installed overhead cranes.

Attention may be called to the excellent manner in which visitors are transported about the grounds. Those who were at St. Louis will probably remember that they had the automobile busses, but they were very hard to enter and alight from. Here they had the so-called Fadjl train.

In the matter of fire protection, Mr. Bayley claimed that no exposition had a fire protection comparable with that installed at this one, and it may safely be said that few communities enjoy an equal security against fire. In addition to the high pressure distribution mains, there was installed a sprinkling system in all of the eight buildings of the main group. In the Machinery Building it was not thought that the sprinkler system would be very effective, owing to the great height of the roof.

The next matter of great importance was that of water supply. In this connection, it was found that the local water company could not supply them with water, and they were confronted with the problem of supplying about two million gallons a day.

Few expositions have ever had an adequate supply of gas. He thought it was safe to say this was the first Exposition that had gas at every portion of the grounds and that in adequate supply. Gas had been a great factor in many respects. Almost all of the cooking in the Exposition grounds was done by gas. In order to cover a square mile of area at a reasonable cost, the high pressure gas system was used. Gas is distributed at a pressure of about 80 lb., and the pressure is reduced by means of governors at the various points of use.

Regarding the gas lighting of the streets, in the State and Foreign sites, there was an installation of over 250 high pressure gas lamps, which he thought was easily the largest in the United States and also one of a very few. Here can be seen the great possibilities in high pressure gas lighting. The gas mains were all welded by means of the oxy-acetylene process.

PAPER BY G. W. DICKIE

G. W. Dickie, in presenting his paper upon Mechanical Engineering at the Panama-Pacific International Exposition, said that in some respects this Panama-Pacific International Exposition differed from all the other international expositions that have been held, in that it represented a changing condition in mechanics. There were no steam engines at this Exposition with the exception, perhaps, of one or two—none of them in operation, and none of any size worthy to be considered as monumental. There was one 500 h. p. double cylinder sawmill engine, which was a very plain piece of work; steam was carried probably seven-eighths of the stroke. But it was worthy of mention as the sawmill engine is built to consume all the power derived from burning all the sawdust the mill makes, and if it cannot do that it is not a success. In order to do that it must not be economical in the use of steam.

DISCUSSION

A. Stucki said that, coming from Pittsburgh, it struck him very forcibly to hear that wood was mostly used in the construction of these buildings. Ordinarily it is said: "Wood is not in order any more. Steel is cheaper and stronger." But here it was found that it is more economical to use wood instead of steel, and he understood that Mr. Bayley had made a very thorough study of it, applying engineering principles. But what struck him most of all, was the foresight exhibited in not only following financial views in getting the buildings installed cheaply, but in protecting them by a sprinkler system for fire protection, such as has not been used before in such magnitude.

H. G. Reist asked whether the same thing would hold today with the Panama Canal opened; that is, whether a large part of the difference between the use of steel and timber was not due to the transportation of steel.

A Member asked Mr. Bayley how they determined in the beginning the approximate floor space required for the different exhibits.

John R. Freeman, referring to the use of wood rather than steel in the framework of the Exposition, called attention to the duty of the interior architect. Even so good an authority as Newhouse has said that we have to compliment engineers for knowing how to make the interior of a building. He had had the pleasure of handling a great many of these expesitions, all the way from that of Paris of 26 years ago to those in Chicago and St. Louis, Portland and others, and he had never yet been in any large building for exposition purposes of a temporary character where the framework was arranged so that it was fancy and beautiful until he came to this Expositon here. He thought a compliment should be handed to the men who designed the interiors of those buildings and worked those trusses out of lumber at $13 a thousand and made them beautiful.

W. C. Lindemann asked if in the consideration of the salvage on the Fair buildings, a definite figure was arrived at, and if so, how it was calculated. In figuring the cost of work, of course, the salvage value has a considerable effect on what the ultimate work is going to be.

A Member asked Mr. Bayley if they have anticipated any system or method by which the salvage on the Exposition installation may be decided on when the Exposition is closed.

Selby Haar, referring to the estimate that was made of the electric load as a load factor of thirty per cent. asked whether that estimate came pretty close to what was actually right.

H. G. Reist called attention to the beauty of these made-to-order cities at the various World's Fair Expositions. This one, is particularly beautiful, both in the individual buildings and in the grouping of the buildings, and it would seem strange that in the building of these temporary cities such beautiful results can be achieved, but in building permanent cites they are built very much haphazard. He felt that it is largely up to the engineering profession to try to make a change so that our permanent cities will be as beautiful as our temporary ones.

G. W. DICKIE, referring to the lack of data in connection with exposition building which was a great handicap to them, said he was sorry that Mr. Bayley did not discover the stupendous report of James Burge, as British Commissioner at the Chicago Exposition, in which there is an immense amount of information. The buildings are all tabulated there as to load and the foundations and also cost of building per cubic yard and foot and square foot of floor, etc.—a very interesting gathering of data, that he thought had been used very largely in expositions, especially in Europe.

MR. BAYLEY, in answer to Mr. Stucki and Mr. Reist, said it was largely a question of settling the height of the buildings when the buildings were being designed. About two and a half to three years before the Exposition opened, there were some grave doubts whether the Panama Canal would be opened at all; in fact some were afraid the Exposition would be completed before the Canal, and at the time there were no assurances whatever that they could get required delivery of steel and also the expense was very much higher. Of course, here they had the timber, and the most splendid timber, delivered for about $13 a thousand and steel didn't have much show. It is largely a matter of cost, and has to be figured both ways—whether the steel can be gotten for a less price. He was very sure that wood would be the cheapest there in any event.

Replying to the question concerning floor space required, Mr. Bayley said exposition building goes by habit, so far as he could ascertain, and he tried to find out how much space was assigned at previous expositions for a certain classification. They had to depend very largely upon the recommendation of the division of exhibits; in fact, that division really specified the amount of space that would be set aside, and it was their thought to divide products.

In reply to the question concerning determination of salvage, Mr. Bayley stated that the salvage value is just a matter of opinion. He believed that in the Western market, they could get rid of the lumber. One would be astonished to know how much second-hand lumber is used on the West coast. The mine people use it for timber work, and it is used for bridges, all sorts of temporary purposes and a great deal of permanent work. Of course, in the question of the selection of timber the salvage practically was not so important. In other kinds of salvage they knew pretty well. For instance, waterproof wire has a good salvage value because the insulation can be burned off readily and there is the copper. With a conduit, however, there is no salvage value and they wanted the cheapest possible initial cost.

In reply to the further question concerning salvage when the Exposition is closed, Mr. Bayley said he was then writing the contract for the sale of the Exposition, as a set of specifications. They would solicit bids to buy the Exposition outright and undertake the salvage, as they did not care to do the salvage themselves. They were satisfied with having built and operated the Exposition, and want to sell it for a lump sum. He said there was a very large amount that was not included, as they were singularly fortunate in getting a very large amount of material on a rental basis, which in fact, effected a very large saving, aggregating almost a million dollars.

In answer to the question of Mr. Haar, Mr. Bayley replied that the load factor of thirty per cent. was so close that it might be said they had advance information; it was a little over 29 per cent.

In reply to the question raised as to why we can build something temporary and make it a unified whole and something of beauty, whereas we fall down in such a remarkable manner when we start to build permanently, Mr. Bayley said he thought the answer was not difficult to see, and it is that they had concentrated control. Take, for instance, the case that so often results in developing civic centers and other monumental groups; one regime will take hold and they will work out a scheme, somebody else will come along a little later, and then another architect will probably succeed him. He referred to a wonderful instance of that in New York in one of the cathedrals; each one of the architects had his own individual ideas. Here, at the Exposition, there is no one man who dominated the architectural situation, but there was an architectural commission. The idea of the block plan made it essential that they all work together. There are different types of architecture, but there is no conflict, because one cannot see three courts at once. One may go around that whole area, the whole length of those buildings, and it was all the work of one man. The result is continuity and harmony. Each man would express his individuality, which, he thought, was really the success of the Exposition; it was due to the fact that they started with a scheme which necessitated harmony; that is, they could not very well go astray, so long as it was decided to have one man, or one element.

PAPERS BY W. H. ADAMS AND A. H. GOLDINGHAM

DISCUSSION

H. R. SETZ called attention to two points of especial interest to all; one is that mentioned in the last paragraph of Mr. Adams' paper, par. 65:

> The item of life of the Diesel engine is open for discussion, but no one can yet say definitely what the life of the Diesel engine, properly taken care of, is going to be, as none of our successful plants have been in operation long enough to give the answer.

In order to get an answer, we will have to look to Europe, because it is in Europe where the Diesel engine had its conception, and where it has been perfected to the highest stage of completion. The history of the Diesel engine in Europe has proven that all the parts which are subject to wear, at least in a well-designed engine, can be replaced at a cost of about 35 to 40 per cent. of the initial cost of the engine. These parts include pistons and cylinder liners, for instance, valves, bushings, and all those parts that are subjected to natural wear of the engine. It, of course, does not include any breakages like broken crank shafts. But such a thing doesn't occur in a good Diesel engine. European practice has brought out that these parts will stand up easily from eight to ten years.

Mr. Setz was in 1901 connected with Dr. Diesel, and was then testing a two-cylinder engine, which some of the engineers that were in Europe about two years ago undoubtedly saw. That engine is operating a match factory in Bavaria now, and at that time, had been in operation for twelve years. The pistons and one cylinder liner have been replaced in that engine; all the other parts are practically the same parts as the original engine contained, and that after twelve years' operation.

In one of the two papers that were presented Mr. Setz noticed that the depreciation is figured at ten per cent. In view of these experiences he thought ten per cent. was far too high to figure. It is doing the Diesel engine an injustice if ten per cent is figured, because in less than eight years the whole Diesel engine will have depreciated from its original purchase value to nothing. He would recommend a depreciation of about four per cent. in trying to arrive at the cost of the power produced in a Diesel engine, including the capital charges.

The other question is, of course, the fuel question. There are about as many different kinds of fuel oils as there are of Diesel engine operators, referring to their suitability. A thing which he thought ought to be done in this country, and probably by the American Society of Mechanical Engineers, is to make a systematic study of fuel oils. There is quite a precedent for work along that line in the more recent European literature. For instance, in Switzerland, a very comprehensive study was made by actually running a Diesel engine for two and three weeks at a time on various fuels. Unfortunately, the fuels that were tried were all, with one or two exceptions, European oils, from Galicia and Roumania and Baku. There were only two American samples of oil used; one was an Oklahoma oil and the other a California oil, which means that only asphalt base oils were used in the tests.

Asphalt base oils are what ought to be investigated. The ordinary manufacturers haven't the time, and most of them haven't the inclination to allow the chief engineer to spend any great amount of time in making such investigations, and he thought that if the fund which is now in existence in the Society for carrying on research work could be drawn upon to carry through such experiments in one of the laboratories of our leading schools under the supervision of several faculty members—impartial men—he thought very good results would be obtained.

Referring to a few examples of what his experience had been on asphalt base oils, Mr. Setz said there is no standard definition for asphalt. Asphalt is defined sometimes as the residue which remains after heating the oil for a certain number of hours at a certain temperature in the open-air bath, as it is called. What remains after such a heating process is ordinarily called asphalt. But the residue contains many other things than asphalt, so that is not a conclusive test at all.

He had had one of the greatest surprises in his life when he started out the first Diesel engine in the Southwest. They told him the oil contained 50 per cent. asphalt, and he thought he might as well go home, because that engine would never run on that stuff. Yet to his great surprise, the engine ran and is running to-day with nothing else than that particular grade of oil. It is a California oil of 14.6 gravity, Baumé, and the engine can even be started and it it regularly started on that kind of oil—a thing which no engineer in Europe who has had European practice would believe possible unless he saw it.

Another method of determining asphalt is by a chemical analysis, and even in that there is no standardization, as Mr. Setz understood. He said he was not a chemist, and could not give conclusive definitions about it, but he understood that even among chemists, there is a difference of opinion as to just what asphalt is. He thought this question ought to be cleared up, and a standard adopted by means of which the oil is designated in the future. It would, he said, be a great help to manufacturers, and a far greater help even to users.

Mr. Setz referred to a publication which came out about a year ago, covering a lot of very interesting and important research work by the United States Geological Survey, covering asphalt base oils, California oils especially. The usual method of designating an oil in regard to its suitability for operation in Diesel engines is to give the gravity, either Baume, or specific gravity. If one goes through that pamphlet and plots graphically all the values that are given for these various California oils over the specific gravity, it will be found that the heat values range from 18,000 to almost 20,000 B.t.u. per pound, and that the percentage of asphalt contents given there varies from about 40 to 42 per cent. It will also be found that what is called kerosene varies also within certain limits. All these things indicate that specific gravity is not the only criterion for determining the value of fuel oil. This is one of the points that ought to be settled, and he believed that no better arrangement could be made than to having the American Society of Mechanical Engineers take this matter up, as it is strictly a mechanical engineers' proposition.

Another matter in connection with oils which Mr. Setz said was referred to several times in one of the papers, is the percentage of water. The percentage of water is not in itself enough to designate the oil as to its suitability for Diesel engine use. For instance, he had been operating on a Mexican crude oil which contained over 2 per cent of water, and the engine ran for quite a while very nicely. All at once it began to run jerky, iregular, and finally, it shut itself down. After investigating he found out that this Mexican crude oil was so heavy that the water remained in it suspended in very small drops, and did not separate out but very little. These very small particles of water, had been pumped in gradually with the oil into the injection valve—not into the cylinder, but into the injection valve on the atomizer plates. That piece of apparatus which will be found described in one of these papers, serves the purpose of disintegrating the fuel before it is injected, and the atomizer plates have a temperature high enough to evaporate the water. This water vapor rose inside of that injection valve space to the upper end of the injection valve, and there gradually condensed and formed a drop big enough so that afterwards, when it was blown into the cylinder, it shut the engine down. The Diesel engine will run on almost anything, but not on water, so there is where the water content would have an effect.

Another oil which contained about 5 per cent of water did not cause any trouble at all, because the oil was of such a constituency that the water was easily separated and could be drawn off; no water came into the cylinder at all.

Another feature of California oil especially, Mr. Setz finds, is the contents of the salts. These salts in the oil dissolve, and when the oil is burned in the cylinder, they form a deposit that, being a form of silicate, is a very effective grinding medium, and will wear out cylinders. Some do not show the effect at all, and others show it in very pronounced manner. This is another thing that ought to be investigated in connection with oils. If the Society could make a systematic investigation, Mr. Setz thinks it would be of great benefit

to this new industry, which promises to become of far greater importance here than it has reached in Europe.

R. L. Rowley asked Mr. Setz what was the smallest size of four and six-cylinder engines, and also the weight now adopted for Diesel work in European practice?

H. R. Setz said the question of weight is entirely dependent upon the speed of the engine. Up to a short time ago, in order to meet requirements of smaller submarine construction, speeds were increased and weights reduced beyond what is considered desirable limits to-day. Later practice is tending towards heavier weights and more rigidity in the engine, so as to insure longer life.

C. R. Weymouth said there is no class of investigators, or no class of experimenters that deserve more credit than the men who have developed and are developing the Diesel engine. They have had to face almost insurmountable difficulties, and he thought the degree of success that they have accomplished is remarkable. They have not, however, conquered the field, and there is a great deal to be said that is not in favor of the Diesel engine, and it was that portion of the subject that he wished to cover briefly.

His own experience had not extended to the Diesel field. About fifteen years ago his company undertook to exploit the Westinghouse gas engine on this coast. They installed between half a dozen and a dozen Westinghouse engines averaging from 50 to 100-h. p. Within two or three years time, after these engines were installed, he thought, every one of them was out of commission. He remembered a letter written to an engineer in connection with one of these plants operating a pump, and this letter was by a person who wished to ascertain the reliability of that type of engine. The party answering the letter stated that it was the most satisfactory gas engine that he knew of; they had made some alterations since it was first installed—they had removed the piston rod and the piston and had put an electric motor on the other end of the shaft, and it was then working perfectly.

Following this period there was installed at Martin's station near this city probably the largest gas engine plant in the United States, other than in the steel industry. This plant had four 5000 h. p. gas engines built by the Snow people. These engines were to run on manufactured gas; they were not involved with any problems of moisture, or silt, or asphalt. It is a well-known fact that the engines were never accepted; after a few years trial, at great expense, the engines were rejected, and their failure cost the International Steam Pump Company the sum of about one million dollars.

Mr. Weymouth asked the Diesel gentlemen here why it is that if engines designed to run under less difficult conditions result in failure, that a much greater degree of success can be expected from the Diesel engine. He knew the Diesel engine had attained a great degree of success, but he didn't understand the reasons for it, and would like to hear from them on that subject. He thought all engineers would admit that the Diesel engine is the most efficient type of prime mover known, and it is probable that no other type of prime mover will ever closely approach it in efficiency. He thought, however, that the majority of engineers would agree that that one advantage is about the only advantage of the Diesel engine, and that, starting from the saving in fuel resulting from its use, there must be subtracted a good many items of operating expense which result in a final operating cost which is not anywhere nearly as favorable as it might appear from the operating efficiency.

When we consider an engine operated with cast iron cylinders, with a temperature of the fire of from 2500 to 3000 deg. and with a piston floating in this flame, the difficulties of complete combustion under those conditions will be appreciated. As a result of the high temperatures and the other attendant troubles from the presence of moisture and silt, the operating troubles of the Diesel engine multiply, and in most of the plants that he had knowledge of, the operating cost is a material figure.

The Diesel engine was developed in Europe where, as a spur to its development, they had the highest fuel cost of any locality, and the saving based on this high fuel cost was such as to warrant a considerable margin in covering such losses as maintenance, high repair cost, operating costs and depreciation. In Europe also they were able to obtain at a comparatively low rate the highest skilled mechanics; they were able to do machine work with a degree of accuracy not formerly known in this country. All of which conditions were conducive to the best development of the Diesel engine. When the Diesel engine is transferred to the Pacific Coast, however, it will find probably the cheapest fuel cost of anywhere in the world. With crude oil at 60 cents a barrel, the fuel is one of the least items of the cost of a power plant, and whatever the percentage of this fuel saved, it means a small saving in dollars and cents.

Furthermore, we have in this country men who are not highly developed in the operation of delicate machinery, and it cannot be expected that the Diesel engine will arrive at its best until after quite a number of years. In our mining regions, where the Diesel engine would find its best development, men are found who are little better than tramps in a great many cases, as men who are skilled mechanics can secure profitable employment in the coast cities, and it is quite a problem to obtain operators who will stay in these unattractive desert locations.

Mr. Weymouth referred to Mr. Adams' paper on page 7: "The Diesel engine is in use to-day in almost all places where a steam engine or turbine might be used." He said that is a very broad statement and might easily be misleading, and the best way to answer a statement of that sort is to go immediately to an extreme. He mentioned that the Commonwealth Edison Company of Chicago is to-day contemplating the installation of a single turbine of 50,000 kw. capacity, and he compared that with an installation of Diesel engines. The largest Diesel engine built in America to-day, that he was aware of, was an engine of about 800 kw. capacity, and of about five cylinders per engine. It would require 60 engines of that size to develop this 50,000 kw. capacity. There should be, say, from five to ten engines reserved; if this reserve figure be called ten, there should be 350 cylinders in a Diesel engine plant to develop the capacity of one steam turbine.

If we go to the question of labor, it will be seen what an enormous number of men would be required. As to the

question of floor space, it would probably be found that there is not a single tract of land in the city of Chicago available for a plant of that capacity. That comparison may be unfair and probably is unfair to the Diesel engine, because he understood they are building larger sizes in Europe, although at the present time these are still in the experimental stage.

On page 14, Mr. Adams gives a comparison of the most efficient steam plant with the most efficient Diesel engine plant. He assumes an efficiency of 34 per cent for the Diesel engine, and an efficiency of 20 per cent for a steam turbine plant. Mr. Weymouth said he knew of his own knowledge that it is possible to operate a steam turbine plant under its most efficient conditions with oil fuel, without undue expense of first cost; that is, with 100 per cent load factor (which is the basis that Mr. Adams is talking on) obtaining 300 kw-hr. per barrel of oil. Taking the ratio of 34 to 20 and multiplying it by 300, that would be for the economy of the Diesel engine plant 518 kw-hr. per barrel of oil. He knew of the records of a number of Diesel engine plants, but he didn't know of any plant which is operating as efficiently as that. The best claims that he knew of are in the neighborhood of 0.7 lb. of oil per kw-hr. And if this be taken on a light oil, which will weigh about 300 lb. to the barrel, it would give somewhere from 400 to 450 kw-hr. per barrel of oil for the Diesel plant. Mr. Adams gives, in his paper, an economy of 447 kw-hr. per barrel of oil, which he thought was a fair comparison.

Mr. Weymouth pointed out that Mr. Adams gives a comparison on page 20 of the cost of the small turbine and the small Diesel engine plant, rating this at 600 kw. He said Mr. Adams had in mind, no doubt, a fair comparison which would be used, thinking of a plant which would be used by a small municipality. In making this comparison the Diesel engine appears at its very best, and the steam plant appears at its very worst. In a plant of 600 kw. maximum capacity, he didn't think that even the advocates of the steam turbine would contend that it is best adapted for this work. There have recently been developed some small steam engines on the uni-flow principle and an engine also of the four-valve type, which are giving remarkable economies; they can be operated on superheated steam and will show better performance in the small units than the steam turbine.

The steam turbine has, of course, an undisputed field in units of larger size, and most people agree that above a 1000 kw. the steam engine has little field. The economies given for the turbine plant may be representative of the steam turbine, but are not representative of the best that is obtainable with steam, and for a steam engine plant properly designed, the fuel consumption would be materially less than indicated.

With respect to the selection of units, Mr. Weymouth didn't think that an engineer would select a 200 kw. and a 400 kw. unit for any municipal plant. The day is past when we put in several sized units in a given station. We don't try to fit the load curve with unit sizes, and in any plant the units should be about the same sizes, for the purpose of duplication and for simplicity in repairs. Even with steam engines he would say that for a 600-kw. plant the unit size should not be less than 300 kw., and probably three units or 300 kw.

For the Diesel plant Mr. Adams selected in one case three 200 kw. units, and in another case one 200 kw., and another 400 kw., but there are no spare Diesel engines. All the Diesel people will agree that a spare Diesel engine is necessary. If this is provided for, it multiplies the first cost of a plant in proportion to the spare, and the fixed charge is increased in this ratio.

On the other hand, in providing the spare engine of the turbine unit, it is not necessary to provide the complement of spare boilers and stacks and boiler house, and the additional spare is provided at a less cost than in the case of a Diesel plant.

Mr. Weymouth said the labor costs are not high enough for the steam plant, and are considerably too low in the case of the Diesel plant. The maintenance cost is taken at eight-tenths of 1 per cent for the steam plant, which is too low, and one-half of 1 per cent for the Diesel engine plant, which is many times too low.

Regarding maintenance, he said that the California State Railroad Commission, in passing recently on the maximum power cost, had allowed $1\frac{1}{4}$ per cent as the maintenance of a steam plant, and he didn't think the Diesel plant could be figured at anywhere near that cost.

Referring to the fixed charges, 14 per cent has been estimated as both the total of fixed charges for the steam plant and the Diesel plant; in both cases this includes the item of 6 per cent depreciation for both types of unit. The whole question of the selection of a Diesel plant or a steam plant for a small unit station will depend upon the relative figures assigned for depreciation. There are none of us in this country that know anything about it, and any figure today is more or less an intelligent guess. He had talked to a number of people who have had European experience, and they told him that the depreciation of the Diesel plant is about the same as a good steam engine. He had asked one of their marine department for some figures on the life of steam engines, and had received a list of steamers operating on this Coast since 1880 or 1881, over thirty years. The depreciation on that basis would be something under 3 per cent. He knew of Diesel plants which had been entirely rebuilt in less than five years; that is, their vital parts.

Taking the figures that Mr. Adams has given for the total cost of operation on a 25 per cent load curve, on 95 cent oil, his power cost is 1.3 cents per kw.-hr.; on \$1.50 oil it is $1\frac{1}{2}$ cents per kw.-hr. There are any number of steam plants all over the country which will show much lower generating cost than that, including all of the fixed charges. There are steam plants on this coast which are operating at easily one-half of those costs.

The Diesel engine has the same economy and almost the same cost per horse power in small units as large units, and the improvement for the larger sizes would not grow at a rapid rate; it would probably be some better than indicated. He would say that Mr. Adams has made a very unhappy selection in taking a 25 per cent load factor to figure out a Diesel engine. He doubted if the advocates of the Diesel engine would pick a situation of that sort, or even recommend their engine for that load. It is well-known that the Diesel engine is best fitted for loads near 100 per cent load factor, because there the saving in fuel is enough to offset some of the greater fixed charges and operating costs.

In connection with Diesel plants working in desert loca-

tions where there is a scarcity of feed water, where there is generally a large content of scale forming matter, Mr. Weymouth asked if the Diesel engine cylinders and jackets are designed to permit the easy removal of the scale which is certain to accumulate. A steam plant, working with surface condensers, he said, is a good salt factory, due to the evaporation of water, and there is a very rapid accumulation of scale in the tubes. He knew of one plant where it was necessary to shut down the condenser every 28 hours, and to drill out the tubes with a twist drill. That condition would prevail in the jackets of the engine. It can be overcome by designing the engine to remove the scale.

Mr. Weymouth remarked that Mr. Setz gave an interesting record of an engine which had been running something like twelve years, but that he didn't give any information as to the kind of oil used, whether it contained silt or other impurities which would give rise to cylinder wear and cylinder ring trouble.

In connection with the submarine practice of the United States, they have on that Coast the greatest amount of Diesel engine experience. The submarines were among the first Diesels on the Pacific Coast. They began with crude oil, but changed successively until they found it was necessary to run with a rather high gravity oil, something similar to Star oil, of about 30 gravity, before they could overcome their troubles.

In connection with the recent discussion as to why so many of our submarines are out of service, it has been pointed out by some of the authors of the Navy, writing articles for journals such as the Army and Navy Journal, that it has been found very difficult to keep these engines in reliable condition. The first report on the sinking of the submarine F-4 at Honolulu, mentions the difficulties of the Diesel problem in general, the unreliability of them, and the difficulty of keeping them in regular operation, but does not assign that as a reason for the sinking of the submarine.

Mr. Weymouth would say in closing that he thought these papers are both interesting contributions to the Diesel engine situation, but he regretted, and he thought all engineers would regret, that it is either not possible to give more reliable information, or it is not the disposition to give more complete information regarding the actual cost of operation of going plants.

A very complete report on this subject was made by the National Electric Light Association in 1912, consisting of reports on 34 stations. That information, however, is not as complete as it should be, and it is claimed that the engines now being designed are better built than the engines that were then in operation. But if an independent engineer today, is to pass on the problem of the relative merits of the Diesel plant, or a steam turbine plant, or a steam engine plant, he can find a great mass of information as to the operating costs and economies of the steam plants, but he will hardly be able to go beyond the stage of guaranties by the Diesel people as to their operating economy.

What we need are records of the life of Diesel engines so that we can estimate intelligently their depreciation and operating costs in the shape of labor, and the maintenance cost, and when that is at hand we will be able to decide what the future will be in California.

Mr. Weymouth said in closing that about two years ago he had the pleasure of showing Dr. Risert, a prominent German engineer connected with the Augsburg factory, over some power plants on the Pacific Coast. As he understood, Dr. Risert was one of the foremost Diesel engine designers in Germany, and he made the statement that while he was very favorable to the Diesel engine from the standpoint of its operation, the fuel cost on this coast was so low that he would not advise his people to attempt to cultivate the field here.

The Chairman: Mr. Dickie, then said they had had both sides presented very fully in regard to the Diesel engine. He was sorry that they did not go a little more into the marine Diesel engine, because he was somewhat interested in that. About five years ago a prominent shipowner in San Francisco wanted to try the Diesel engine; he had a boat building for his lumber business, and wanted an engine of 1200 h. p. The owner told him that he could spend $100,000 on that engine if he wanted to, so he wrote to a firm of engine builders whom he knew very well and could depend on. They asked for samples of the oil to be used, and he sent then some twenty samples of oil from the California wells, just as it came from the wells. They would not undertake to build any Diesel engine that would run and be depended upon with that kind of fuel. On that account the application of the Diesel engine to the Coast shipping service stopped, and there has been no other attempt made that he knew of to bring the Diesel engine to service on that Coast. However, he said they may get to a Diesel engine that can be depended upon—and, really, he said, up to certain sizes, they are dependable to a certain extent, although the operating expenses, as shown by Mr. Weymouth, are pretty high, and the engine room force have to be all skilled men.

Mr. Dickie said they had one ship in there not long ago with 2200 h. p., which is a very small installation for a ship, and it had ten certificated engineers. That wouldn't go here, he said. A Swedish certificated engineer doesn't get very much wages; he is paid about the same as we have to pay a fireman here, and that makes quite a difference. All these things have to be taken into account when we come to the matter of deciding whether the Diesel engine, or some other form of engine is the best thing to use for any specific purpose that we have in view.

A. H. Goldingham said in response he thought most of the criticisms had been on the Diesel engine rather than on the hot surface type engine. He called attention to the fact that his paper was on the heavy oil engine, both the hot surface and the Diesel. But there were two things that he would refer to.

First of all was the cleaning out of the water spaces. In the later designs of engines this has had particular attention. First, there is a separate liner for removal in the cylinder, so that the scale can be removed, and also hand holes are provided, so that they can be well taken care of, both in the cylinder head and in the cylinder itself.

Second, with regard to the cost of operation, there is no question but that the oil engine, to have its best advantage, must be where fuel is expensive and where the load factor is high. The oil engine, as he had pointed out in his paper, to show to the best advantage, must work at or near full load all the time. Of course, its great advantage is the economy of fuel. Where you get very cheap fuel its advantage fades away slightly.

PAPER BY G. H. MARX AND L. E. CUTTER

DISCUSSION

L. D. BURLINGAME remarked the fact that Prof. Marx has carried out his series of investigations to cover one of the features which go to make up a successful gear whets our appetites for further investigation along the lines of efficiency in gearing, and to cover other important factors which go to make up successful running gearing. Some of the other factors are the matter of wear and the matter of quiet running, and we can only get at the most satisfactory or successful system of gearing by taking all of these matters into consideration, rather than taking one. While an investigation of this character is of value as giving data on which we can base further investigations, before we can decide what is the best system of gearing, we must have these other matters also taken into consideration.

For example, the Committee on Standard System of Involute Gearing, which investigated various systems, found from their tests that the $14\frac{1}{2}$ deg. angle gear gave a decided greater percentage efficiency, and a quieter running gear. In arriving at a compromise which will give us a system of gearing for universal application, these things must all be taken into consideration, and as he understood, the matter could be carried further if funds were available. It seemed to him that a very desirable use of funds which might be available for research work could be made to carry out further experiments along these lines.

The question of strength of gearing, Mr. Burlingame stated, is affected very possibly by this consideration: that with the small pressure angle ($14\frac{1}{2}$ degrees for the Brown & Sharpe system) the pinions being the weaker element, that is, where a small pinion runs into a large gear, the engineering solution is to make the gear of steel, or if further strength is required, to temper the pinion and thus get the benefit of strength without sacrificing the question of wear or of quiet running.

In the paper of Prof. Marx, it is interesting to note on page 7, where the figure is given for the actual breaking load of the Brown and Sharpe gear, that the curve of actual break is materially higher than the theoretical curve on which the figures are based. This is interesting as showing that the figures as given in this pamphlet are on the conservative side and are such as can be used with safety, that is, with a larger margin of safety than perhaps the actual facts would warrant.

It is also interesting to note the suggestion as to contact with more than one tooth during the action of the gearing, with a question mark against the three teeth being in action during certain parts of the action of the gearing. This is largely a matter of accuracy of cutting and of the system on which the teeth are based. He doubted if in many cases three teeth are actually in operation, from the fact that the point of the tooth of the ordinary Brown and Sharpe gear is eased off for quiet running in a machine; that would probably prevent actual contact unless under extremely heavy pressure.

Mr. Burlingame felt that Prof. Marx's contribution is one of direct value to the engineering profession, and sincerely hope that the work can be carried further.

KATE GLEASON said that one of the very interesting things to her that Professor Marx had found in studying the Lewis formula as compared to the work he is doing, is that the strength did not fall off on high speeds, as he found, as rapidly as Mr. Lewis found it. The trouble they found is just as Prof. Marx found, that the strength does not fall off at the high speeds, but the load is apt to be so much harder —the starting and stopping at the high speed—that a great deal more has to be allowed in practice than in tests.

For instance, in rolling mill machinery, running at a high speed as it often does, if they are trying to run mills with motors almost double the strength has to be given than would in even the Lewis formula, whereas, in the Lewis formula on machine tool gears it is found more than ample. It seemed to her that as the loads come on so quickly, it acts almost like a hammer on the gears and crystallizes the material, and though the material may be plenty strong enough for the first month or two, it will disintegrate if not provided for, perhaps by putting in nickel steel, or something of that kind.

Miss Gleason stated that they found in the same way in testing worm gears, that they will not show up on a test at all as they do in practice. We have had papers here showing efficiencies up to 90 per cent on worm gear drives, but when we go out in practice, where the load comes down and makes so much friction, we cannot get 20 per cent out of it sometimes.

G. H. MARX replied that it had been peculiarly interesting to him to have Miss Gleason discuss the paper, because it was about twenty-five years ago, when he was working for the Gleason works in Rochester, that his first interest in gearing began, in connection with the preparation of a trade catalogue and pamphlet—a small treatise on gearing, which he had to get out. That interest had never failed, and although these experiments have been very tardy in coming off, he was very glad to have them done now.

What has been said by both speakers he heartily agreed with. In the first place, these experiments are limited merely to the question of strength, which is a very small part of the whole problem, and they are limited to cast iron gears. But he said, the only way to get an investigation done is to take a small portion of the field and cover it as thoroughly as can be, and then take the neighboring area and perhaps go into that. It takes a great deal of time, as any one who has carried out any investigation knows, to clean up even a small portion of a question like this.

As to the question of the falling off according to speed, of course, it was as Miss Gleason said, and she must remember that these tests were made under running conditions. He said their plea is that where there is shock, where there are reversals of stress, or where the stress is suddenly applied, that factor should be taken care of by a proper factor of safety and not in a velocity coefficient. So they have separated those and have a factor of safety in their formula, in which the question of the matter of application of load, or the question of reversal of stresses is provided for.

JOINT MEETING AT PROVIDENCE

An unusual joint meeting of local sections of the Society took place recently in the joint gathering of the Boston local section with the affiliated society, the Providence Association of Mechanical Engineers. The occasion was made notable by the attendance of several prominent engineers from distant points, who delivered addresses on engineering topics, and the opportunity for social intercourse was taken advantage of by a dinner gathering at which 520 were seated, preceded by a number of excursions to industrial plants in the afternoon. The meeting was said to be one of the most successful ever conducted by an engineering organization.

A JOINT meeting of the local section of the Society of Boston and of the affiliated society, the Providence Association of Mechanical Engineers, was held at Providence, R. I., on November 18, 1915. Members and friends to the number of 290 arrived in Providence by special train from Boston early in the afternoon, and proceeded at once to visit several of the manufacturing plants of the city.

At five o'clock they arrived at Brown University to inspect the engineering laboratories, and at 6.15 P.M., 520 engineers and friends sat down to dinner at the Narragansett Hotel, the largest gathering of engineers that ever dined together in Providence. Many could not attend on account of lack of room.

After dinner the visiting engineers were welcomed by Mr. Arthur H. Annan, President of the Providence Association of Mechanical Engineers, who said:

We are in the midst of a great industrial centre. Its prosperity depends upon the success of those industries, which in turn depend upon the successful efforts of their engineers. Their work is done singly or in small groups. We are constantly, and increasingly, witnessing the great achievements of organizations by concerted action, and who more than the engineers should appreciate and profit by such proceeding? I believe that we may profit and extend our influence and coöperation to every phase of our industrial, commercial, educational, social or any other function of a civilized community which is influenced by the work of engineers.

Dr. W. H. P. Faunce, President of Brown University, was then introduced by the toastmaster, William Howard Paine. Dr. Faunce said that he represented the "poor college professor," while the engineers represented, not the "malefactors," but the factors of great wealth. Continuing, he told of:

A certain country preacher, who met a famous baseball pitcher, and said to him: "What is the cause of the difference in our salaries? I get \$500 a year and you get \$5000. Moreover, I work twelve months in the year and you work only three and yet my salary is \$500 and a miserable little parsonage thrown in, and you get \$5000. What is the reason for that?" And the famous pitcher said: "I suppose the difference is all in the delivery!" While there is a great deal of difference in our delivery, yet there may not be after all so much difference in the things we are aiming at. On an evening like this I am conscious of the unities rather than the divergencies.

It has often been assumed in America that the men of thought were utterly distinct from the men of action; that the men of thought are to be found inside of the college fence, and that the men of action are outside in the world doing things without any deep intelligence. But the engineering profession stands for the union of thought and action. It stands for intelligence and labor, for thoughtfulness put into industrial and commercial enterprise, and says to all the world: "Your labor is thrown away, unless you think as you work." On the other hand, it is equally clear that thinking will come to little unless somehow it is harnessed into the great creative activity of the age."

Following Dr. Faunce, addresses were given by Professor Charles E. Munroe, Washington, D. C., on Explosives and the Engineer; by Morris L. Cooke, Philadelphia, Pa., Mem. Am. Soc. M. E., on Experiences of an Engineer in Public Office, and by M. C. Rorty, New York, on The Development of a National Telephone System.

After Mr. Rorty's address moving pictures were shown of the construction of and scenes along the transcontinental telephone line. At 9.30 P.M., through the courtesy of the American Telephone & Telegraph Co., telephone connections were made with the Exposition grounds at San Francisco, Cal., every person present having a receiver connected to the transmission line so as to hear the long-distance conversation.

EXPLOSIVES AS AN AID TO ENGINEERING

BY CHARLES E. MUNROE,[1] WASHINGTON, D. C.,

Non-Member

Engineering is one of the oldest of the professions. But as we contemplate the temples, the tombs, the pyramids, the obelisks, the fortifications, the highways, the aqueducts, the viaducts, the mines and tunnels and the other monuments to man's achievements which have come down to us from most ancient civilizations in many parts of the world, in view of the tools, appliances and materials now at the command of and in use by the engineer, one is led to inquire into the means by which such work was then accomplished.

Although gunpowder is recorded as having been used as a propellant at the siege of Baza by the king of Granada in 1323, its first appearance in military engineering operations, as recorded, was at the siege of Merat in 1397, where it was used for springing mines. In 1585 it had come to be used in marine devices, for, in that year a bridge in Antwerp was destroyed by a floating torpedo. The first reputed application of this agent to peaceful pursuits is attributed to Martin Weigold (Weigel) at Freiberg, Saxony, in 1613. Guttmann doubts this because as late as 1617 Lohneyss wrote "on the soft veins they work with pickaxes, but in the solid ones with gad and mallet." Guttmann recognizes that the art of blasting was naturally an evolu-

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Presented at joint meeting of the Providence Association of Mechanical Engineers and the Boston local section of The American Society of Mechanical Engineers, held at Providence, R. I., November 18, 1915.

tion and holds that the first practical application of which there is authentic record was made by Caspar Weindl on February 8, 1627, in the Oberbiberstollen of Schemnitz in Hungary.

For over two centuries gunpowder remained the only available blasting agent, but in 1845 Schoenbein discovered gun cotton, in 1846 Sobrero discovered nitroglycerine, in 1866 Nobel invented dynamite and a new era in explosives for engineering uses began. Guttmann dates the application of these new sources of energy to blasting as 1854, but without citing person, substance, or place. In the early days of blasting the charge in the bore hole was ignited through the stemming by spills or squibs, consisting of straws, quills or rush tubes filled with fine powder. In 1831 William Bickford invented the running fuse in use to-day wherein a thin, continuous core of powder, along which the fire might slowly travel at uniform and determined rate, was enclosed in a jute tube. In 1867 Nobel introduced detonators.

To-day the preferred method of firing blasts is by electricity; therefore Americans should be interested to know that history states that Franklin, in his Letters on Electricity (June 29, 1751), was the first to suggest the employment of frictional (or static) electricity for the ignition of gunpowder, and that in 1831, Moses Shaw of New York, made the first application of this method to the firing of mines. Meeting with practical difficulties in putting his invention into industrial operation Shaw, on June 1, 1831, appealed to Dr. Robert Hare of the University of Pennsylvania for advice and assistance, and the latter applied his famous deflagrator or voltaic battery and a wire bridge to this use with such complete success that, though the generators for the electric current have been altered in form and character, and the detonators in details, the method devised by Dr. Hare is the method which is to-day in universal use throughout the world for the firing of blasts, mines, or torpedoes by electriicty. This method was demonstrated for use in warfare when in 1843 Samuel Colt blew up a brig under full sail in the Potomac from Alexandria, which was 5 miles distant from the brig, though in 1839 Sir Charles Pasley had removed the wreck of the Royal George at Spithead by the use of low tension fuses.

The blowing up of Flood Rock in Hell Gate, in New York City, was successfully accomplished October 10, 1885. Flood Rock had a superficial area of nine acres, about 250 sq. ft. of which was above water. The rock consisted of hornblende gneiss, with intersecting cross-veins. A sea-wall 7 ft. high was built around the island, and two shafts were sunk, one 67 and the other 40 ft. deep. The main shaft was used for removing the excavated rock in blasting out the headings. The smaller shaft was used for the tubes conveying the compressed air which drove the drills. The first series of headings branched out from the main shaft at a depth of 40 ft., and from the bottom of the shaft another series diverged directly under those above. The headings branched at right angles every 20 ft. and were 60 in number in each tier. The double system of headings was employed to gain a sufficient depth after the explosion without the necessity of dredging out to the extent that was found necessary at Hallet's Point. The total length of tunneling was about four miles, consisting of 24 galleries running north and south and 46 running east and west. The longest of these was 1200 ft. in length, 6 ft. wide and 10 ft. high. There was a thickness of from 10 to 25 ft. between the roof of the top tier of galleries and the water. There were 467 pillars, 15 ft. square, left to support the roof. The whole rock was honeycombed with tunnels, about 80,000 cu. ft. of rock having been removed.

There were drilled in the pillars and roof 13,286 chambers for holding the cartridges, each chamber being 3 in. in diameter and about 9 ft. deep. These chambers were filled with rackarock cartridges, of which there were about 47,000 used, each being $2\frac{1}{2}$ in. in diameter and 2 ft. in length, and containing about 6 lb. of the explosive. In addition to the rackarock cartridges, several hundred ordinary dynamite cartridges were used, to which the wires leading to the firing batteries were attached. The shock resulting from the explosion of these dynamite cartridges caused the explosion of the rackarock. Upwards of 285,000 lb. of explosives were used in the charge.

The wiring in the mine was divided into 36 circuits, the batteries attached to these circuits being stowed in a tool-house on the rock. The wire of the primary circuit which actuated the electro-magnet that closed the secondary circuits was led across to the Astoria shore on the morning of the explosion. The firing-key was about 1200 ft. from the mine.

Two siphons, one 12 in. in diameter and the other 3 in., were set at work at 10 A.M., October 9, flooding the mine, and they completed their work early the following day. The first effect of the explosion was to produce a rumbling noise, and then to project a mass of water over an area of about 1200 sq. ft. to a height of about 150 ft. Masses of rock rose in the midst of this water to a height of from 40 to 50 ft. The explosion lasted about 30 seconds. As the water fell a dense cloud of yellowish smoke arose and floated over the Astoria shore.

After the explosion the rock appeared undisturbed, though on close examination it was found to be somewhat fissured. However, it slowly settled, and by October 13th the entire rock was below water. It was not intended that the rock should be broken very fine, since with the appliances at hand pieces of from ten to fifteen tons in weight cou'd be most economically handled. The operation covered nine years, and cost upwards of $1,000,000. (Proc. Nav. Inst. 9, 755; 11, 281.)

More than 30 years ago the author began a study of the conditions of efficiency in the use of explosives and in a paper published in Van Nostrand's Engineering Magazine for January 1885, which dealt with attacks on armor, demonstrated that the maximum degree of confinement for the explosive and penetration by the projectile were the essential conditions. In 1898, apropos of the use of the dynamite gun at Santiago, I returned to the problem and published my results in Cassier's Magazine of that year, of which I gave a resumê in an address to the citizens of Cleveland on behalf of the American Association for Advancement of Science and which appears in the Popular Science Monthly for February 1900 as follows:

> There is a widespread misapprehension in regard to the devastating effect of these high explosives, for when unconfined the effect even of large charges of them upon structures is comparatievly slight. At the Naval Ordnance Proving Ground, so long ago as 1884, repeated charges of dynamite, varying from five to 100 lb. in weight, were detonated on the

face of a vertical target consisting of eleven 1-in. wrought-iron plates bolted to a 20 in. oak backing, until 440 lb. of dynamite had been so detonated in contact with it, and yet the target remained practically uninjured; while at Braamfontein the accidental explosion of 55 tons of blasting gelatin, which was stored in railway vans, excavated but 30,000 tons of soft earth. This last may seem a terrible effect, but the amount of explosive involved was enormous and the material one of the most energetic that we possess, while if we compare it with the action of explosives when confined, its effect becomes quite moderate.

At Fort Lee, on the Hudson, but two tons of dynamite placed in a chamber in the rock and tamped brought down 100,000 tons of the rock; at Lamberis, Wales, $2\frac{1}{2}$ tons of gelatin dynamite similarly placed threw out 180,000 tons of rock; and at the Taleen Mawr, in Wales, seven tons of gunpowder, placed in two chambers in the rock, dislodged from 125,000 to 200,000 tons of rock. We might cite many such examples, but on comparing these we find that the gunpowder confined in the interior at the Taleen Mawr was over forty-two times as efficient as the explosive gelatin on the surface at Braamfontein, while the dynamite at Fort Lee was over ninety times as destructive.

These views have received but little consideration from officials in this country and our Government has gone on spending money in the testing and use of devices which were certain to prove ineffective. However, I confidently point to Liege, to Namur, to Antwerp and to the effects of a multitude of perforating high explosive shells used in the present war in confirmation of the principles I developed. One has but to scrutinize the pictures in the Scientific American for October 30, 1915, showing the effect of shell fire on the Emden to be convinced of the accuracy of these conclusions.

Shortly prior to 1898, and while he was Chief of Bureau of Ordnance, U. S. N., I was asked by Captain Sampson to assist in the tests of armor piercing projectiles then being conducted at Indian Head by Comdr. Couden by securing a high explosive charge for them. This was done and after proving an excellent degree of fragmentation in the fragmentation pit a shell containing 8.25 lb. of the explosive was fired through 14.5 in. of the Harveyized armor of the U.S.S. Kentucky and exploded on the inner side. So far as records go this had then never been approached.

When Admiral Sampson took command of the fleet he wrote me asking my assistance in securing high explosive charges for the armor piercing projectiles of his fleet. I delivered his message and used my best endeavor, but the material called for was not sent and it remained for the Japanese to be the first to demonstrate in practice the soundness of these principles.

This study was continued and extended to bore-holes in blasting operations by my pupils, Clarence Hall and W. O. Snelling, and their results and conclusions were published in 1912 as Technical Paper No. 17 of the Bureau of Mines under the title "The effect of stemming on the efficiency of explosives." It was naturally of interest to learn that a manager of a considerable mine reported a saving of $50,000 in his explosives' account in a single year by following the methods for using stemming taught by this research.

More recently Edgar A. Collins has stated in Min. Sci. Press, Vol. 110, p. 790, 1915, that he has found in practice where 30 per cent ammonia gelatin was being used in a given mine a saving of 25 per cent in quantity of the explosive was effected by increasing the depth of the tamped stemming above the charge and that as a consequence the amount of explosives issued to the miners had been cut to from 10 to 20 per cent of that formerly issued.

It should always be remembered that the gases produced by explosives in exploding have other properties than that of yielding larger volumes than the solids from which they are produced, for some of them are poisonous. The kind of gases produced differs with the kind of explosives used and the way in which it is used. Nitric esters and nitrosubstitution compounds and the mixtures, such as dynamite, made from them, may yield poisonous nitrogen oxides and cyanogen, and poisonous and inflammable hydrogen sulphide and carbon monoxide. But if the explosive be properly compounded, well confined, and fully detonated, these harmful gases will not be produced, for the gaseous products will then be largely composed of water and carbon dioxide; and though carbon dioxide may cause unconsciousness and even death, it does so only when it forms a large proportion of the atmosphere. Blasting powder and gunpowder-like mixtures give off poisonous and inflammable hydrogen sulphide and carbon monoxide under all conditions of explosion.

The production of inflammable gaseous products underground, especially in coal mines and bitumen mines, is most hazardous. The production of poisonous gases, either below ground or on the surface, is a source of danger, and if such gases are formed they should be removed by ventilation before anyone is allowed to approach the working place. Neglect of this precaution led to the death of 7 persons and the rendering of 40 others unconscious from gas poisoning following the firing of 21,000 lb. of blasting gunpowder at the Crarae quarry, Loch Fyne, Scotland, on September 25, 1886. The quarry was situated in a basin in a hill with sides rising 25 to 250 ft. and was approached by a narrow gorge. The blast was fired in the presence of an audience of over 1000 persons and at least half an hour after the blast 120 got into the quarry to observe the effect, and within five to six minutes after entrance they began to fall, overcome by the poisonous powder gases entangled in the crevices of the rock that had been thrown down.

In a large engineering project in the West nine men lost their lives as a result of the poisonous gases produced on the detonation of 40 per cent strength gelatin dynamite in a long tunnel. After igniting the blast the men retired about 500 ft. to wait for the smoke to clear, and while they were waiting the smoke drifted slowly over them, and then, owing to some change in the air current, drifted slowly back again. The men felt the usual symptoms of carbon monoxide poisoning—slight choking, nausea, profuse perspiration, and headache—but they all revived upon reaching the open air about an hour and a half after the blast had been fired. Within a short time, however, the men began to cough and spit bloody mucus and show other symptoms of nitrogen peroxide poisoning. In less than three days 9 out of the 13 men who had been in the tunnel and exposed to the fumes had died; the other four, as well as those who went in with the motor to bring out the men, were ill for days and even months after the catastrophe.

It was soon after the accident mentioned above that special studies of the noxious gases evolved on the detonation or combustion of different explosives were undertaken by the Bureau of Mines to determine whether improvements could be made in the composition of explosives with a view to increasing safety in mining.

EXPERIENCES OF AN ENGINEER IN PUBLIC OFFICE

BY MORRIS L. COOKE, PHILADELPHIA

Member of the Society

Mr. Cooke prefaced his remarks by saying that he must admit experiencing somewhat of a thrill as a result of this large and enthusiastic meeting of engineers—more than could crowd into the hall. This event and the recent accomplishment of the engineers of his home city in their remarkable campaign for increasing the membership of the Philadelphia Engineers Club, by which it was raised from 560 to 2300, indicated to him a growing strength on the part of the engineering profession, and of a corresponding opportunity open to the profession.

He said that municipal administration, in which he had had a part, had been conducted on the assumption that there were almost no fundamental differences between public and private businesses. He believed that he and his associates had the right to claim that this was distinctly a novel idea in municipal administration, and that as the years went on it would be looked upon more and more as an important step forward. He said further:

The public official cannot do at all times all that he would like to do, which is as true also in private establishments. We sometimes assume that those in nominal control in business really control. But whether we speak of the men or the management, such control is only relative—never absolute. If much that we dreamed during the past four years was frustrated by those opposed to us, we must admit that it would be just as true in industry or anywhere else.

As an offset it can be claimed that anything good which is accomplished carries further because of the publicity which frequently comes to public business. The difficulty usually is that public officials are not always able to get publicity, nor to make the people understand their purposes and work. A man in private business frequently answers that he does not have to give his reasons—even resents being asked for them; but a public official should beg for widespread public discussion of public problems, for only in this way can he get the necessary public support for those things which deserve support. Too frequently the public has either half information or misinformation.

This assumption about the similarity of public and private business has stood us in good stead at every turn. Thus we have assumed that our Civil Service laws were only a codification of the best practices of private business and that considerations which would make John Wanamaker, Baldwin Locomotive Works, or any other good employer, either employ, discharge or discipline, should hold with us. Acting on this theory we have not once failed to get the man we wanted through Civil Service and the courts have not reinstated a single man, although it has been necessary to discharge hundreds.

In the broad group of municipal engineering activities none are of more importance than those classed broadly under the head of public utilities, including therein steam and electric railroads, gas, water and electric plants, and telegraph and telephone companies. When we came into office the municipality exerted almost no control over these properties, most of them both privately owned and privately operated.

The city had almost no reliable information about these utility companies and therefore was in no position to enforce the most modest demands either for improvements in service or readjustments in service. No one will ever know the difficulty we have experienced in ascertaining enough of the facts to put us in a fair negotiating position. Practically every American city is in the same situation. And yet every city should at all times be in possession of all the facts about every utility which serves it. We will look back some day upon this period of utility hide-and-seek as one does on the dark ages.

We look upon our activity in this field as our greatest accomplishment. We have not only wrought many local improvements in the utility situation in Philadelphia, but our influence has been felt all over the country. Largely as the outcome of our local difficulties, has come the National Utilities Bureau with a distinguished directorate, which with headquarters in Philadelphia is acting as a counselor and guide in utility matters to cities all over this continent. As a standardizing and economizing agency the influence of this bureau is already making itself felt. It provides the only forum in this country for the expert and untrammeled discussion of utility problems.

However great we may feel to be the opportunity of the engineer in this municipal field, the public will come only half way. As a profession we must go forward to meet our opportunity. No narrow view as to the scope of engineering can be tolerated, and we should bring to our aid the most exalted conception of service which we can command. Ever since I have been a member of The American Society of Mechanical Engineers, I have made the effort to arouse the interest of my fellow members in our responsibilities to the public as contrasted to those we owe to our profession. After four years of direct association with the engineering problems of the third largest city in this country, the necessity for your coöperation is all the more apparent. There is no national engineering society taking a special interest in municipal engineering. I wish ours could do so.

William Ostwald—one of the greatest leaders of present-day Germany—has called our attention to a fundamental difference between the science of the future and science as we know it to-day, or more particularly as we have known it in the past.

The change from a pseudo-science to a real science only comes when we begin to use the knowledge we have as to the present and the past to build a future which we then proceed to make come true. The astronomer bases his predictions as to the future on the race-long accumulation of data. The hour at which to-morrow's sun will set may have been figured out centuries ago and perhaps with an inspiring degree of accuracy, and yet such figurings have not the slightest influence on the event. In the same way species have come and gone and their life histories have been in no wise influenced by man.

In California, however, a Burbank pictures a flower with heretofore unheard of qualities—a new color, a new shape, or perhaps a new perfume. Then by combining and recombining known varieties under laws, some of them known and some of them not even recognized, and—presto! the sought-for flower. Again a Flexner in New York or an Erlich in

Frankfort draw the specifications for a bacillus that shall bear down some enemy of the race, and forthwith it is produced.

It does not require a great imagination to picture this force broadly at work in the field which has to do with the interrelations of men. In greater and greater degree in the science of human institutions we will have the power, if we can get that point of view, to write the formulas for the future according as we see what will be for the benefits of our kind.

Engineering has had much of service in it. I am told by municipal researchers that, taken the country over, no other class of officials has a better record for probity or the painstaking execution of public trusts than have our municipal engineers. No one of us will underestimate the meaning of such a statement. Inspiring though a good record may be, all its value is lost if we do not use it as a stepping stone to something greater, to deeper service, to a more profound understanding of all that life of which we may be a part.

Engineering must more and more be looked upon as the great coördinating branch of human endeavor. To bring order out of chaos can be rightfully claimed as our job. More and more our client must be all the people.

THE DEVELOPMENT OF THE NATIONAL TELEPHONE SYSTEM

BY M. C. RORTY,[1] NEW YORK

Non-Member

Man has been called the "tool using animal," and his progress has been so closely identified in the past with his skill in the manufacture and use of tools that we hear frequently of the stone age, the age of bronze, and the iron age, as representing broad divisions in human evolution. But it is not proper to speak in terms of tools of the hand alone. We might, perhaps, more accurately speak in terms of the development of the tools of the mind, and might divide the years of man into the dumb ages, the age of speech, the age of picture writing and hieroglyphics, the age of the alphabet, the age of printing, and, finally, the ages of the telegraph and the telephone.

It was no accident when Alexander Graham Bell, more than 39 years ago, in the City of Boston, spoke into such an instrument to his assistant, Thomas A. Watson, over a line less than 100 ft. long, the first words ever transmitted by electrical telephone. Bell had been an instructor of the deaf and dumb, and, perhaps more than any man of his day, was practically familiar with speech and the mechanism of speech. He had that vision, inspiration, and enthusiasm which, in the inventor, is without price. His years of study and experimentation gave wings to that first telephone message.

It was no accident, also, that in the development from crude beginnings, which reached its logical climax on Monday afternoon, January 25, 1915, this same Alexander Graham Bell, in our offices in New York, talked with this same Thomas A. Watson in San Francisco, over a circuit stretching 3400 miles across the continent, and serving to unite into one great system 9,000,000 telephones connected by 21,000,000 miles of wire.

And, finally, it was no accident that, in the last few days, this apparently finished work has been added to by transoceanic speech by wireless—with a whisper swelling, if need be, to hundreds of horse power, and spreading simultaneously in vast etheric waves, from Washington to the Eiffel Tower in Paris, on one side, and, on the other, to the distant Island of Hawaii.

Hundreds of inventors and engineers, in the 40 years since Bell and Watson held their first telephonic conversation, have labored ceaselessly for these great results, and levies have been made upon every branch of science and mechanics.

The problem has been a difficult one, not from its magnitude, but rather from the very subtlety and delicacy of the forces with which the engineers had to deal. It was not much more difficult to string wires from Denver to San Francisco than from New York to Denver, but the physical construction of the line was the least of the troubles. The real problem was to make that line talk, and to send 3000 miles with the breath as its motive power. The voyage of the voice across the continent is practically instantaneous. If its speed could be accurately measured, a fifteenth of a second would be nearly exact.

But the breaking of speed records is not the only thing which the telephone must accomplish. It must also guarantee safe delivery of the millions of tiny passengers which it carries every few seconds in the form of electrical waves created at the rate of about 2100 per second.

A breath against a metal disk changes air waves into electric vibrations, and these vibrations, millions upon millions of which are required for a single conversation, must be carried across the continent and produce the identical sound waves in San Francisco that were made in New York or in Providence. This task is so delicate and so fine as to be gigantic.

The transcontinental telephone line is much more than a mere scientific achievement. No one who stands in a modern telephone exchange in a great city and watches the tides of human activity ebb and flow—rising now swiftly with some great public crisis, falling with equal swiftness when the crisis passes—can fail to realize that this line is but the last link in the building up of a vast, sensitive, and truly universal service.

Such a service was anticipated in a remarkable way by the inventor-prophet Bell when he wrote, just two years after his first telephonic conversation had taken place:

> It is conceivable that cables of telephone wires could be laid underground, or suspended overhead, communicating by branch wires with private dwellings, country houses, shops, manufactories, etc., etc., uniting them through the main cable with a central office, where the wires could be connected as desired, establishing direct communication between any two places in the city. Such a plan as this, though impracticable at the present moment, will, I firmly believe, be the outcome of the introduction of the telephone to the public. Not only so, but I believe, in the future, wires will unite the head offices of telephone companies in different cities and a man in one part of the country may communicate by word of mouth with another in a distant place.

But even so farseeing a man as Bell must seek aid when it comes to establishing a public utility of continental scope. And we shall fail in our duty to-night, if, in paying tribute

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Presented at joint meeting of the Providence Association of Mechanical Engineers and the Boston local section of The American Society of Mechanical Engineers, held at Providence, R. I., November 18, 1915.

to the inventor, we fail to pay tribute, also, to the organizer, the constructor, and the engineer.

For many years this line from ocean to ocean has been the dream of Mr. Theodore N. Vail, president of the American Telephone and Telegraph Company, the goal toward which he has pushed and toward which he has steadily led his associates. This has not been an idle fancy of a dreamer, but the prophetic vision of a practical, forceful, capable man of unlimited business knowledge, who can see everything in telephony, except impossibilities. He not only cannot see impossibilities, but he will not admit that they exist.

At Mr. Vail's side through most of these years has been a slightly built, active, keen-eyed man, John J. Carty, chief engineer of the American Telephone and Telegraph Company, and the organizer and directing head of what is, perhaps, the most remarkable group of technical workers that has ever been assembled for the accomplishment of a specified purpose. Mathematicians, physicists, chemists, experts in design and manufacture, and experts in field construction—each man has been selected with the utmost care, and practically every university and scientific school in the country can count its graduates within the group. Team work, imagination, and thoroughness have been the secrets, if secrets there be, of their success. To award individual credit among so many who are deserving would be a hopeless task. The greatest element in the whole sustained program has been leadership.

As a mere piece of construction, the building of a telephone line across the continent is impressive. For instance, the line crosses 13 states; it is carried on 130,000 poles. Four hard-drawn copper wires, 165/1000 of an inch in diameter, run side by side over the entire distance, establishing two physical and one phantom circuit. One mile of single wire weighs 435 lb., the weight of the wires in the entire line being 5,920,000 lb., or 2,960 tons of copper. This amount of copper is required for the transmission lines alone. In addition, each one of the physical circuits has some 13,600 miles of fine hair-like insulated iron wire 4/1000 of an inch in diameter, in association with it for the magnetic cores of its loading coils.

Simply to string this immense amount of wire across the continent, to set the poles and insure insulation, to conquer the innumerable difficulties offered by land, water, forests, mountains, desert, rivers and lakes, was in itself a task of no mean magnitude.

But a still greater task has been the building of the human organization that maintains the line day by day in operative condition and that maintains also the millions of active telephone terminals spread from ocean to ocean, without access to which the copper of the transcontinental circuits might as well be back in the mines from which it came and the poles back in their original forests. No group of isolated companies could build a transcontinental telephone line, or, if it were once built, could maintain it for a week in operative condition. The single-minded purpose that caused the line's construction must operate with equal singleness of mind each minute and each hour of the day to maintain it in service.

Such an organization, also, and all of the many similar organizations that are lending themselves in good spirit to the public service must have the wherewithal to work, the assurance of reasonable profits and public good will and coöperation to-day and for the future, if they are to do the great constructive work that the nation demands.

For a final word, it is something more than a pet phrase to say that, in this country, we need only transmission—not translation. Differences in language are vital things. The great European conflict is perhaps even more a war of languages than it is a war of peoples and dynasties.

It may be an extreme statement to say that if we had had a national telephone system before 1860, the Civil War would not have been fought, but it is probably true that the railroads, the new canal, and our universal telephone service have all combined to weld our people together in a lasting unity.

FOREIGN REVIEW AND REVIEW OF THE PROCEEDINGS OF ENGINEERING SOCIETIES

At a meeting of the Council on October 8, 1915, it was voted to approve the recommendation of the Publication Committee to include in The Journal a review of the world's technical press. In accordance with this resolution, the Engineering Survey will contain, in the future, in addition to the material as hitherto published, abstracts from engineering publications in the English language. This feature will be developed gradually, however, beginning with the publication of a few abstracts in each issue, selected with a view to placing on record the more important developments in mechanical engineering.

ENGINEERING SURVEY

In engineering, there are still a good many "traditions" which have been accepted some time in the past and persist mainly because a general impression prevails that the thing is right and is therefore to be accepted by everybody as being right. This condition continues until some one takes the trouble to investigate when and how such a law or rule was proved to be right, in which case it often develops that it never was proved to be right, and that it is, in fact, entirely wrong. Such a situation existed in the early days of electrical engineering, when, with respect to direct current motors, there was a sort of accepted dogma to the effect that the external resistance should be equal to the internal resistance: This held the efficiency of the generator down to about 40 per cent. Then came Thomas A. Edison, who stated that he did not see why the internal resistance should be so high; that what he wanted was to deliver current outside and not inside. The Jumbo was built and showed an efficiency of over 80 per cent. Apparently similar considerations led to the assumption that a valve on an air compressor or pump will close without shock if the closing occurs exactly at the dead point in the motion of the piston. As a matter of fact, this is not only practically impossible, but theoretically wrong, and in order that the valve should close free of shock, the closing must occur *after* a reversal in the motion of the piston. This, and several other considerations of a very interesting nature, are brought out in the article on the analysis of the motion of valves, by Klepal, in this issue.

THIS MONTH'S ARTICLES

In the section, Aeronautics, are abstracted two interesting articles—one of direct practical importance, on aeronautical timber, by J. E. Huson, in which the author, among other things, calls attention to the great variation in the mechanical properties of timber, depending upon the original size of the log, time of felling, interval between felling and sawing, and the position of the test pieces relatively to the heart of the tree. The other article in the same section refers to the application of the law of similarity to balloon models, and among other things, brings out the importance of the variation of the coefficient of air resistance with the nature of the surface of the body moving through the air.

A description of an improved type of suction producer gas locomobile is given. Its main feature is an arrangement permitting the separation of the cooler from the producer and, as a result, a far more effective cooling than has previously been obtained on locomobiles of this type.

An extensive and well illustrated abstract of an article on German apparatus for the measuring of pressure and velocity of gases will be found in the section on Measuring Apparatus. The question of apparatus of this nature became of particular importance in Germany since the adoption by the German Society of Engineers, of the standard rules for testing air compressors and blowers.

An article on the holding power of nails is abstracted indirectly from the Indian Textile Journal.

In the section, Steam Engineering, are described some tests of a 300 h.p. superheated steam locomobile, of interest because it shows a comparatively low fuel consumption and the ability of the plant to carry a very large overload. A brief description of an improved dry back marine boiler and some data of tests of same are given.

A description of a laundry for the handling of ships' washing is abstracted from a German publication.

In a paper before the American Society of Civil Engineers is described the automatic volumeter, an apparatus intended to gage the flow of fluids by the collection of a proportional part of the flow, or its equivalent, in a small vessel where it can be readily measured at any time. In order to design this apparatus, the coefficient of flow through small orifices had to be established, and experiments along these lines, partly reported in the abstract, have revealed totally unexpected conditions. These experiments were made both with water and with oil.

Professor G. L. Larson, in a paper before the American Society of Heating and Ventilating Engineers, reports tests on the recirculation of washed air, in which, among other things, he calls attention to the fact that recent investigations (some of which have been reported in the Engineering Survey), have shown that what is known as bad air is caused preeminently by the physical conditions of the air with respect to temperature, humidity and movement. It is both unnecessary and uneconomical to supply large volumes of air in order to obtain good ventilation. Carbon dioxide as high as 20 parts of 10,000 does not have a bad effect upon ventilation, and ventilation by recirculation is both efficient and economical.

An important series of tests on the shearing resistance of reinforced concrete beams is published in the Transactions of the Canadian Society of Civil Engineers. Of especial interest is the establishment of the fact that stirrups tend to quite materially raise the ultimate strength of he beam and that when they are set 4 in. apart, shearing failure is practically eliminated.

From the Memoirs of the College of Engineering of the Imperial University of Kyoto, Japan, is briefly abstracted a

paper on the Leonard control applied to mine hoists, of interest because it gives general equations of the resisting moment of hoist as well as equations from which may be found the mechanical relations between acceleration and retardation.

The Purdue Engineering Review reports some tests of standard and clasp brake rigging for passenger train service, made lately on the Lake Shore and Michigan Southern Railroad, and indicating that on the whole, the clasp type of brake is the more proper design to use for heavy passenger equipment.

Vulcanizing experiments on plantation Para rubber, made at the laboratory of the Department of Agriculture of the Federated Malay States, indicate that if the rate of cure be known or ascertained under specific conditions, vulcanized rubber having similar chemical properties, can be made from all good samples of "first latex" rubber so that both plantation and wild rubber may be used equally well. The same tests have established the fact that the rate of cure itself is due to the presence of some substance in the latex, which probably acts as a catalyst and accelerates the rate of cure. The paper suggests the issuance of certificates giving the correct rate of cure and mechanical properties at that cure.

From the bulletin of the University of Illinois are reported experiments made for the purpose of determining the influence of temperature on the strength of concrete.

Aeronautics

Aeronautical Timber, J. E. Huson

The paper discusses the question of the use of various timbers for aeroplane construction from a purely technical point, without regard to the special conditions of supply created by the current events in Europe.

The natural fallacy in considering timbers which besets engineers used to calculations in metals is the unconscious assumption that all perfect specimens of timber are homologous, which is by no means the case. A flawless piece of ash sawed from the outside of a tree will vary in specific gravity, tensile strength, elasticity, etc., from a piece of the same log sawed nearer the heart and both would differ from timber riven instead of sawed. Timber sawed from young trees would differ from that obtained from older trees grown in the same locality. Timber only partially seasoned gives different values from timber "bone dry." Ash grown in sandy soil differs from that grown on a clay or chalk soil and that grown in a coppice from that in the open field. That grown at a high altitude and bleak aspect differs from that in a lower and more genial position.

Tables of tests therefore are to be handled with caution and their information would be more valuable if they were supplemented with full descriptive notes as to the region, original size of log, when logs were felled, interval between the felling and sawing, how long in the stick after sawed, and the position of the test pieces relatively to the heart of the tree.

Two important points should be steadily borne in mind: *first,* that timber is mainly a natural growth and therefore varies with all of the many factors affecting growth, and *second,* that time is an essential factor in proper seasoning. When ordering timber for aeroplanes, it should be remembered that the smaller the dimensions asked for, the greater the choice of timber for quality and no attempt should be made to get large planks of such a size as will cut economically for two or three different sizes.

It is much more difficult to obtain ash straight in the grain for a good length than it is to procure silver spruce absolutely straight. Further, there is a greater variation in the properties of ash than there is in those of silver spruce; hence, when designers have the option of specifying silver spruce or ash, and can afford the extra bulk and increased head resistance to bring the strength of spruce up to that of ash, it would seem prudent to prefer the former.

As to hickory, although the best grade is stronger than the best ash, yet it is a wood which varies considerably and it is doubtful whether on the whole, weight for strength, it has any advantage over ash. It is, however, extremely tough and is probably the best wood for skids. It should not be used in hydroplanes as it is subject to rot in water.

The writer does not recommend kauri pine for aeroplane work. It is extremely liable to be knotty, is heavier than silver spruce and inferior to it in physical properties. Rock elm has no advantage over ash in strength and other properties and has the disadvantage of being usually sold in solid logs.

Mahogany is used by two or three contractors. In working out designs it should be borne in mind that the actual thickness of mahogany is a saw-cut less than the normal thickness. It is valuable in that it is not affected by water and if carefully chosen should be a very good wood for aeroplane work.

Yellow cedar will not rot in water and hence it is suitable for hydroplane boats. Parang is a species of mahogany, stronger and more fibrous than the Honduras variety. It has been used for dirigible propellers. Teak is a highly suitable wood for workings in hot climates. Oak is not used in aerial construction (*Aeronautics* (London), vol. 9, no. 102 (new series), p. 219, September 29, 1915, 2 pp., *gp*).

Law of Similarity and Balloon Models, C. Wieselsberger

At the Model Testing Laboratory of Aeronautics connected with the University of Göttingen, a series of tests have been carried on for some time on the application of the law of similarity to the case of balloon models and on the influence of the nature of the surface of the model on the air resistance. In this article are described tests on four models, the purpose of which way to establish, *first,* the applicability of the law of similarity in general, and *second,* the variation of the coefficient of air resistance with the nature of the surface.

The four models had the general shape shown in Fig. 1A, having been made by electro deposition of copper. The surface was carefully smoothed with emery and then covered with a layer of japan varnish so to prevent oxidation. The midship diameters were respectively 93.6, 132.1, 188.7 and 268.8 mm. (3.68, 5.13, 7.42 and 10.58 in.). Measurements were made in an air stream having velocities up to 23 m. sec. (75.46 ft. per second). The data of these tests are shown in Fig. B, by the full drawn lines, the coefficient of air resistance ψ being plotted as a function of the Reynolds coefficient,

$$R = \frac{vd}{\nu}$$

In accordance with the law of similarity, the coefficients of resistance of all models ought to lie on a single curve. Actually, however, each model seems to have a curve of its

own, which is principally due to the fact that it proved to be impossible to construct models absolutely similar to one another, and there are, in each case, slight deviations from the accepted shape. Experiments have shown that these deviations have an unexpectedly great influence on the resistance of the body. It has been further found that the coefficient of resistance rapidly decreases with the increase of the Reynolds coefficient, but when the Reynolds coefficient becomes very large, an increase begins in the coefficient of air resistance. The strong decrease of the coefficient of resistance with the increase of air velocity corresponds to the transition from a laminar to a turbulent flow and when the Reynolds coefficient exceeds 200,000, the flow is distinctly turbulent. The velocity of air could not be reduced sufficiently to obtain values of ψ for the laminar state.

The models were then covered by balloon cloth with the rough non-rubberized side upward, and the resistance measured anew. The data of these measurements are indicated in Fig. B by the broken lines. It was not to be expected that the law of similarity would hold for this case since the roughness of the surface could not be geometrically the same for all the models. What is remarkable, however, is the entirely different shape of the ψ curves, which in this case rapidly increase with the increase of the Reynolds coefficient and assume an irregular wave-shaped formation.

The influence of the nature of the surface was further investigated on one of the models (No. III): first the bristling fibres on the surface of the model were burned off by a rapidly moving flame and the resistance then determined. The result was very remarkable (Fig. C). The coefficient of resistance which was formerly quite small at low velocities, increases to two and a half times at the greatest velocity available. Next the cloth-covered model was treated by the Cellon-Emaillit process as usually applied to aeronautical cloth (this process usually requires the application of three layers of Cellon-Emaillit A, which is then rubbed off by fine sandpaper, after which two layers of Cellon-Emaillit B are applied). This treatment reduced the resistance to still lower values than had the models with smooth copper surfaces. Next, the models so treated were provided with a layer of High-Brilliancy Emaillit varnish, which gave them a mirrorlike surface. A further reduction of resistance was obtained, within the region of velocities available, only with the Reynolds coefficient below 160,000, but at higher velocities the ψ curve rises again somewhat.

In the next article, the same author describes investigations on the measurement of air resistance in a free air stream and in a tunnel with circular plates and flat planes (*Mitteilungen aus der Göttinger Modellversuchanstalt, Zeits. für Flugtechnik und Motorluftschiffahrt*, vol. 6, nos. 17 and 18, p. 125, September 25, 1915, 8 pp., 9 figs., *et*).

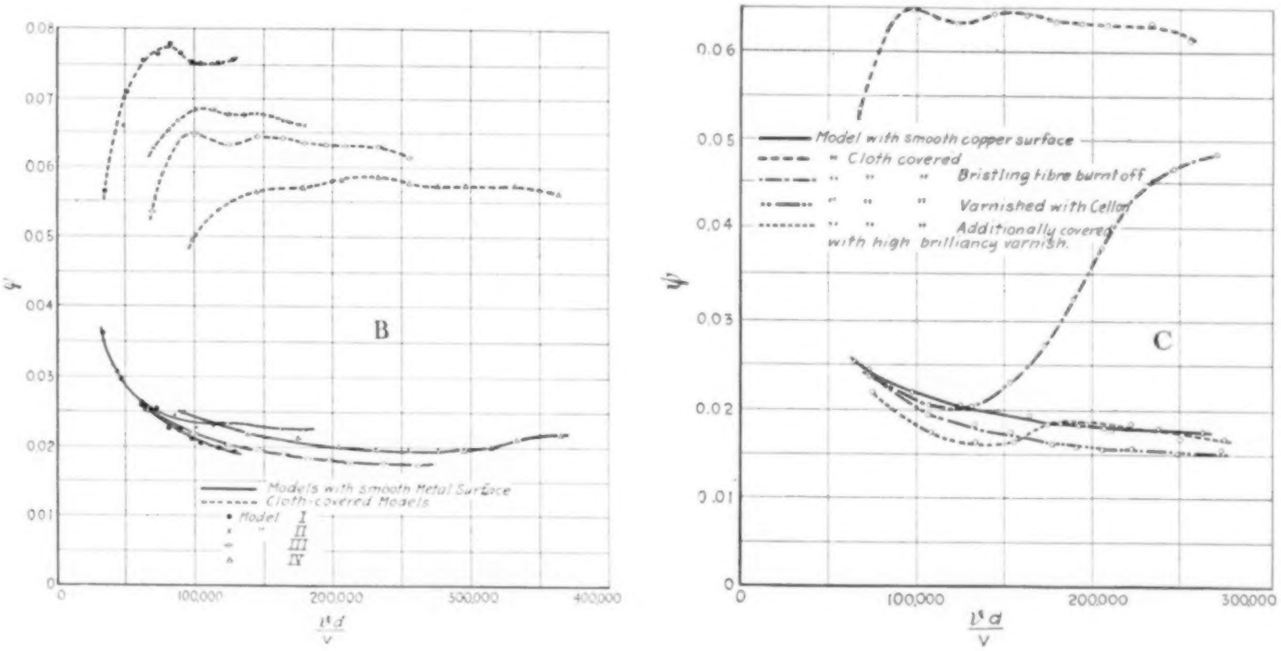

FIG. 1 RELATION BETWEEN NATURE OF SURFACE OF BALLOON MODEL AND AIR RESISTANCE

Internal-Combustion Engineering

LOCOMOBILE DRIVEN BY SUCTION PRODUCER GAS, Gwosdz

Description of an improved modern type of suction gas producer locomobile built by the machine factory of the Royal Hungarian State Railways.

The important requirement in the design of a suction gas locomobile lies in compactness of arrangement of the main elements of the plant; i.e., the gas producer, cleaner and engine. In older designs, the producer and gas cleaner were located in the same shell, which served also as a support for the engine. In addition to the fact that such a construction made access to the gas producer in case of repairs considerably more difficult, there was also the disadvantage that the cleaner, which had the duty of not only cleaning the gas, but also of cooling it, was too much exposed to the heat from the gas producer and received the gases at too high a tem-

perature, which increases the difficulty of cooling. The next step was to arrange the producer and cleaner separately, but even here they were so close together that a free cooling of the gas before entering into the cleaner did not prove feasible.

The Machine Factory of the Royal Hungarian State Railways has placed on the market two designs, in both of which (the latter has an annular shape and is placed around the evaporator *c*). The gas is first cooled to quite a considerable extent in this connecting pipe, and also by contact with the front wall of the cleaner, likewise exposed to the atmosphere. This boiler wall is also part of the entrance chamber *e*, which on the other side is separated from the washing chamber by a wide wall, *f*, ending in a sharp edge

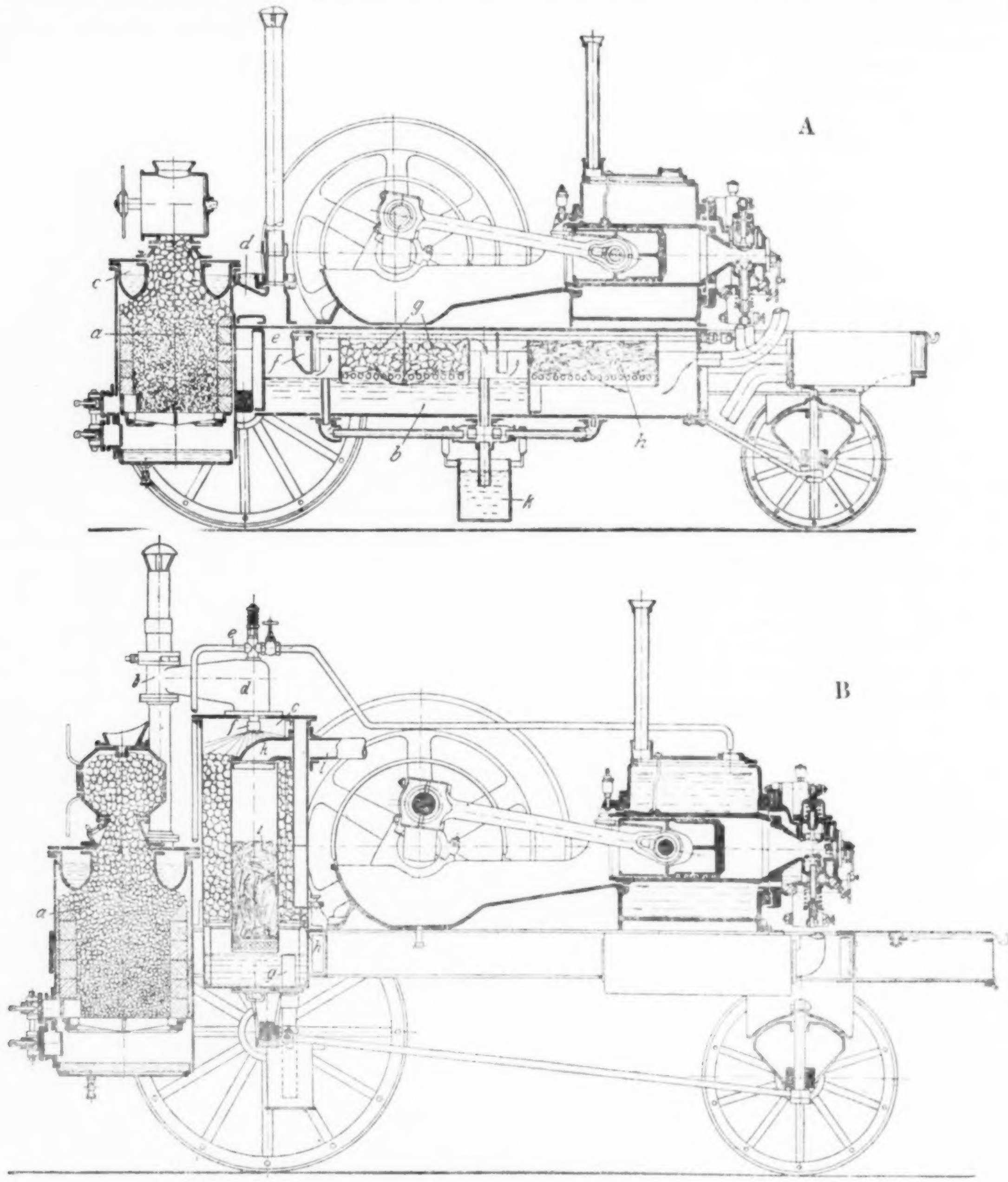

Fig. 2 Improved Suction Producer Gas Locomobiles

the above difficulties are said to have been obviated. The first of these designs is shown in longitudinal section in Fig. 2A. The producer *a* and the engine are located on separate under frames, with the engine lying directly on the flat cooling and cleaning shell *b*. The producer is separated from the cleaner by an intermediary space, fully exposed to the atmosphere, and connected with it by a wide conical pipe *d*, which branches off at the level of the gas collector and coming down to nearly the water level. From the entrance chamber, the gas goes to two scrubbers *g*, and from them, through a dryer *h*, filled with wood fibre, to the gas engine. The water which collects in the cleaner is allowed to escape through the overflow pipe to the trap *k*. On the front side of the gas producer there is located a hand driven fan for blowing the fire. All the cleaning chambers have side openings, closed by tight covers.

As fuel, coke, anthracite and charcoal may be used. With the latter, the attendance is especially simple and the cleaning is no more trouble than with a gasoline engine. This is due, of course, to the low ash content and the easy gasification of the charcoal. The favorable experience in running a producer on a suction gas locomobile with charcoal led to a still greater simplification of the cleaner.

In the design, shown in longitudinal section in Fig. B, the cleaner no longer supports the engine frame, but is a separate container located between the gas producer and engine frame, so that the gases in passing through it encounter considerably less resistance than in the former design. The gas producer *a* is suspended in the front part of the frame, and the gas passes from it through pipe *b* into the container *c*, located between the U-shaped beams of the frame. In the angle arm between pipe *b* and container *c* is built in the cooling water pipe *e*, provided at the opening with a nozzle *f*. The container *c* is equipped in its lower part with an overflow pipe *g* and sieve-shaped wall *h*. The latter is passed through in the middle by the tube-shaped drying tank *i*, located concentrically to the sides of the walls of the container *c*, this drying tank *i* being in its turn built in its lower part like a sieve. The top is connected by an elbow element, *k*, to the rear wall of the container *c*, and is connected with a long transmission pipe *l*, leading to the cylinder head of the engine. Container *c* carries both sieve *h* and some filtering material (coke) and the dryer space, *i*, is filled with clean iron filings.

The gas flowing through the bend *d*, goes therefore to the upper chamber of the container *c* through a sheet of water, and in doing so is effectively cooled. After it has passed through the coke filter of the scrubber and then through the dryer, it goes to the pipe *l*, in which it is further cooled on its way to the engine. This simplification of the cleaner and cooler results in a reduction of the power consumed in the suction. (*Neue Sauggaslokomobilen*, Gwosdz, *Zeits. für Dampfkessel und Maschinenbetrieb*, vol. 38, no. 40, p. 329, October 1, 1915, 3 pp., 3 figs., *d*).

Measuring Apparatus

GERMAN APPARATUS FOR MEASURING PRESSURE AND VELOCITY OF GASES, E. Stach.

Descriptions of various apparatus for the measurement of pressure and velocity of flow of gases.

The simplest and most widely used apparatus for measuring pressure in gases is the vertical U-tube with alcohol or water for low, and mercury for average pressures. In order to increase the movement of the column of liquid there may be used two liquids of different densities as shown in the apparatus of Dr. Rabe, Fig. 3A. The liquids differ here both in specific gravity and in color and their dividing plane forms the zero point. Because of the displacement of the level of the liquid under pressure on the side of the lighter liquid, the displacement of the dividing plane is influenced by the ratios of cross sections and specific weights and, generally, dimensions and liquids are so selected that the deflection is at least twice as great as it would be with a water column. In order to throttle the movement of the liquid and to reduce the tendency of the two liquids to mix under strong variations of pressure, there is produced in the right hand tube of the apparatus a throttling by means of the glass ball *c*. When the pressure to be measured is above atmospheric the apparatus is connected at *a*, and when below atmospheric, at *b*.

Another apparatus, for fine measurements of pressures from + 0.01 to + 25 mm. of water, is diagrammatically shown in Fig. B. The vessel which contains the measuring liquid (distilled water) is divided by a partition into two airtightly separated chambers *a* and *b*. When a pressure above atmospheric is measured, the connection is made at *d* and for measurements of pressures below atmospheric, at *e*. By means of a millimeter screw provided with a measuring wheel divided into 100 parts, the needle *s* can be screwed down until the galvanoscope *f* shows a deflection. Full millimeters are to be read on the scale *m* and fractions on the micrometer. The apparatus must be protected from vibration.

A manometer for fine measurement of fluctuating pressures is shown in Fig. C. It has a vertical measuring tube and is filled with absolute alcohol. It consists of a wide vessel made of cast iron provided with hose connections and a vertical stand pipe. Between the vessel and pipe there is located a cock shown in the front part of the drawing, by which may be effected either a direct connection or one through narrow brass tubes of different lengths located under the vessel. These last tubes act as a damper of the fluctuating deflections of the apparatus in accordance with their length which in its turn depends on the position of the cock. At first the pressure is connected without any damping and the oscillations are then quieted down by means of a gradual insertion of tubes of various lengths, whereupon rapid and correct reading of pressure can be taken. The reading is done through a small magnifying glass located adjustably on a laterally held bar. With this magnifying glass is connected a little mirror, giving an inverted image of the meniscus. A fine adjusting screw is moved until it appears through the magnifying glass that the tip of the screw and the image of the meniscus touch each other. The reading is actually effected by means of a nonius and magnifying glass on a micrometer scale divided into fractions of a millimeter. For measuring average pressures, both above atmospheric and vacua, mercury filled manometers constructed on the principle of a barometer are mainly used. Fig D shows such a vacuum gage built by R. Fuess. The sign "Marke z" indicates the exact level of mercury when the gage is not connected. The connection between the glass tube and screwed pipe-joint *mr*, which leads to the condenser or a similar apparatus, is made by means of a heavy hose *s*. The left tube (with the scale) is not as long as a barometer, since usually, for example in condensers, vacua from 60 per cent. on are of interest only. The scale to the left reads in millimeters of mercury, and to the right in absolute pressures. For gage pressures above atmosphere, such as occur for example with blowers, the left part is also made like a barometer tube, but of a length of about 1.6 m (41.7 in.) and pressures are likewise given in absolute units. For reading very low pressures, a so-called micromanometer is used, which is usually equipped nowadays with an adjustable reading tube and either a variable or a permanent zero point. The article describes the micromanometer of Recknagel and Berlowitz. They are not described as another micromanometer (Fuess) has already been described in *The Journal*. (October, p. 194).

Indicating and Recording Pressure Gages: The older types are described, such as the Oehwaldt gage. Of greater interest is the gage designed by de Bruyn, Fig E, and the line of apparatus built by the Hydro-Apparatus Company. As shown in Fig. F, in the latter motions of the float are

transferred to the indicator hand in the same way as in a spring manometer. In Fig. G is shown a combination of a recording pressure gage and a differential draft indicator. The recording of the differential draft with simultaneous retension of the indicating scale has been secured by raising the diagram drum and providing a second scriber. If it is and below it, due to the reversal of the valves of the chambers. For the variation of pressure above and below atmospheric, alternating by about the same amount, the zero point is located in the middle of the diagram. The section of such a diagram is shown in Fig. K. The abscissae give the times and the ordinates, pressures + 50 mm. of water. The nearly

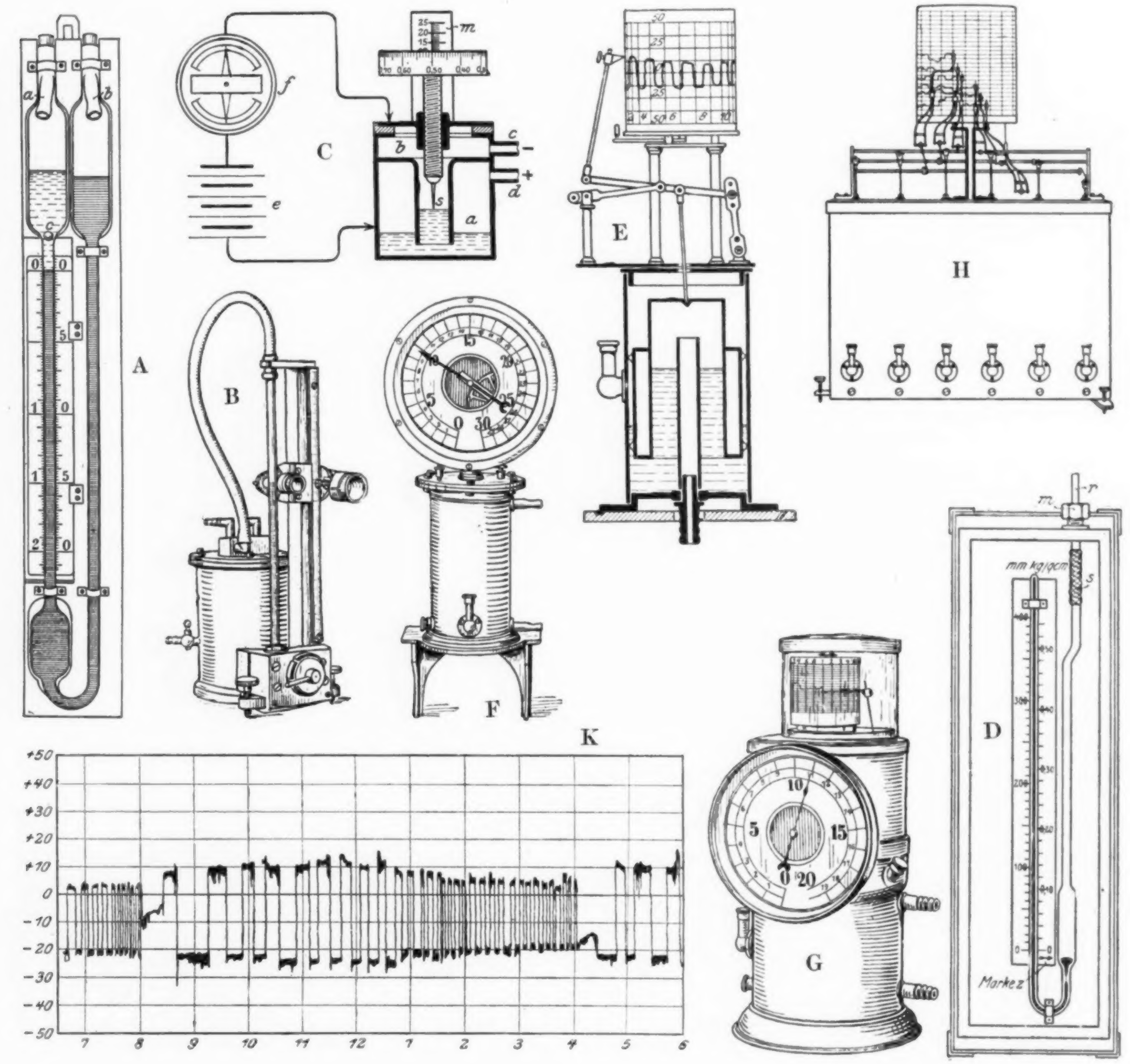

FIG. 3 A, RABE DRAFT GAGE; B, G. A. SCHULTZE PRESSURE GAGE FOR FINE MEASUREMENTS; C, PRANDTL MANOMETER FOR MEASURING FLUCTUATING PRESSURES; D, R. FUESS VACUUM GAGE; E, DE BRUYN PRESSURE RECORDING GAGE; F, HYDRO PRESSURE GAGE; G, HYDRO PRESSURE INDICATING AND RECORDING GAGE; H, PRESSURE RECORDER FOR SIX POINTS OF MEASUREMENT; K, DIAGRAM OF A PRESSURE RECORDING GAGE ON AN OPEN-HEARTH FURNACE

required to record the pressures from several points of measurement, the gage shown in Fig. H (for six points of measurement) can be used. It is self-explanatory.

For measurements on regeneration firing plants, such as open-hearth furnaces, coke ovens and glass melting furnaces, it is important to be able to record the time sequences as well as the height of alternating pressures above atmospheric vertical lines indicate the times of reversal of the gas or air valves.

The article also describes the pressure recorder of de Bruyn for high pressures. (*Messgeräte für Druck und Geschwindigkeit von Gasen*, E. Stach, *Zeits. des Vereines deutscher Ingenieure,* vol. 59, no. 41, p. 832, October 9, 1915, article not finished, *d*).

Mechanics

Analysis of the Motion of Suction and Pressure Valves, O. Klepal

The motion of a valve embraces four stages: 1. Opening of valve; 2. Forward motion, away from seat; 3. Backward motion, toward seat; 4. Closing. In theoretical investigations it has hitherto been the practice to treat the stages 1 and 2 combined, but the author proposes to show that this method of procedure is not correct and may lead to wrong conclusions.

The opening of the valve is brought about by the motion of the piston. In order to overcome the pressure p, over the area F, above the valve (Fig. 1), the motion of the piston must exert below the valve a pressure p_1, which may be calculated from the equation

$$p_1 = p\frac{F}{F_1}$$

where F and F_1 are valve areas above and below. To this must be added the pressure required for the acceleration of

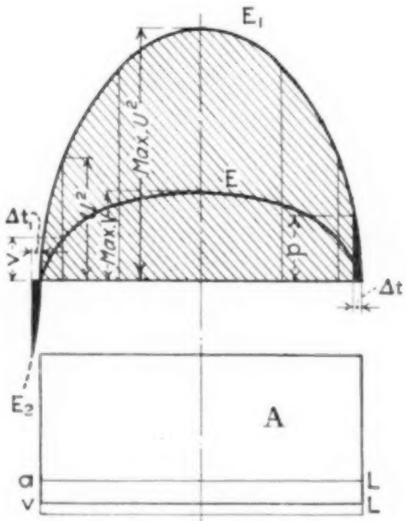

Fig. 4A Valve Motion Diagram for Pump

the valve mass, for lifting the weight of the valve (when the valve moves vertically) and for overcoming the friction at rest in the valve guides, together with overcoming resistance, due to the action of the valve springs. The difference in pressures $p_1 - p$ must be as small as possible. This presupposes narrow valve seats, and small weight and mass of valves as well as small friction and the balance of the mass.

Up and Down Motion of the Valves: After the pressure below the valve has forced an opening and a slit is formed between the seat of the valve and its cone, there commences a flow of fluid (either in drops or as a gas), through the cross-section F_1, this flow proceeding with a velocity which increases with the increased velocity of the motion of the piston (upward stroke) and decreases with its decrease (downward stroke). There act, at any point of its path h (valve stroke) on the area of the valve, the following main and auxiliary forces:

Main Forces

a Impact of the stream of fluid P (called in the discussion following, "stream impact").

b In the case of valves loaded by springs, the force of the spring P' acting in the opposite direction.

Auxiliary Forces

a In vertically moving valves, the weight on the valve G.

b The friction in the valve guides $\pm R$, which acts always in a direction opposite to that of the motion of the valve and therefore changes its sign.

c The force $\pm B$, which produces acceleration of the mass of the valve and is supplied on the upward stroke by the stream impact and on the downward stroke by the valve

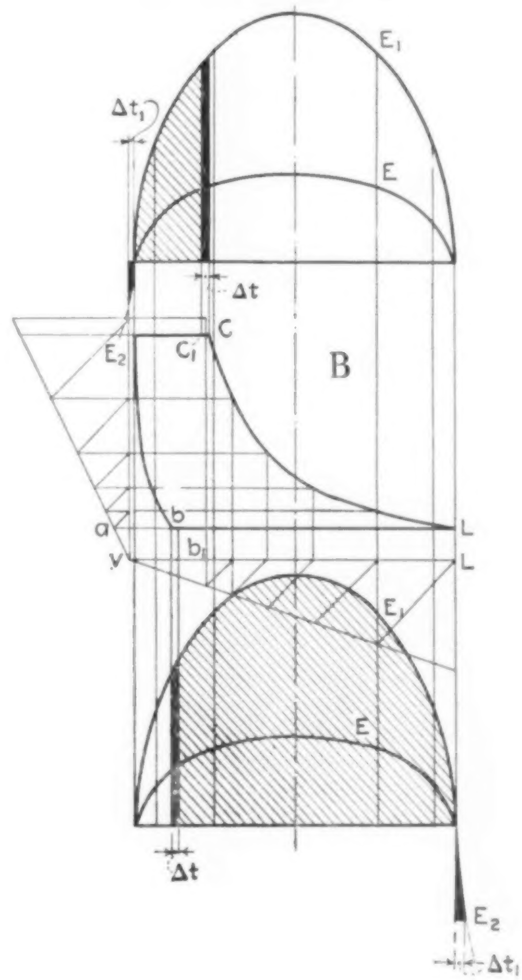

Fig. 4B Valve Motion Diagram for Air Compressor

spring. Hence, to the upward stroke of the valve applies the equation

$$P = P^1 + R + B + G \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

and for the downward stroke of the valve

$$P + R + B = P^1 + G \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

In the above equations, P, P^1 and B are variable, R may be assumed to be constant, and G is constant. G may be assumed to be known, as it depends entirely on the design of the valve. All the other variables are dependent on the magnitude of the stream impact and for the present this essential for the knowledge of the valve motion element is taken to be unknown, and the author considers it quite problematic whether its value can be at all established with a precision sufficient for practical purposes. If it can be done, it will require extensive and costly experimentation.

In this connection the author quotes what Professor Körner wrote in 1908 (*Zeitschrift des Vereines deutscher Ingenieure,* page 1842 and following): "Even with stationary valves and very simplifying assumptions, the direct analytical determination of the pressure (stream impact) exerted by the stream of water, presents insuperable difficulties. My experiments in this connection have not resulted in obtaining values which would be sufficiently complete and in agreement with the actual values, even though a certain functional dependence could be found. Still less soluble proved to be the problem when the motion of the valve itself exerted an influence on the pressure to be determined and hence, this method of research had to be abandoned."

It appears, therefore, that the magnitude of the stream impact cannot be determined by calculation. It may, however, be found graphically. Let F represent the area of the piston in qcm., f, the area of free passage of the valve in qcm.; maximum v, the greatest piston velocity equal to the velocity of the crank pin in *m;* maximum u, the greatest velocity in the valve cross-section which can be calculated from the equation: $\max u = \dfrac{F.\max v}{f}$ in m. . . . . [3]

It will be assumed for the present that the magnitude of the stream impact is proportional to the square of the instantaneous velocity in the valve section. In Figs. A and B, the magnitude of the stream impact is represented separately for liquid pumps on the one hand, and compressors, air pumps and blowers on the other, respectively.

In correctly working pumps, it has hitherto been assumed that both the suction and the pressure valves remain open or closed during the entire stroke of the piston and that the stream impact acts on the valve during the entire stroke. It will be seen that this view is only approximately correct. Of decisive value so far as the motion of the valve is concerned is, however, the operating pressure and its influence will be here considered. In the case of pumps, compressors, etc., we have to distinguish two kinds of working pressures: *the working pressure exerted on the suction valve,* and *that with which the pressure valve is working.* Usually, except in the case of multi-stage compressors and air pumps, the working pressure at which the suction valve is operated, is approximately equal to atmospheric in the case of a compressor and is below atmospheric with pumps, in accordance with the suction head. Because of the final width of the valve seat there must be in the working cylinder above the suction valve a pressure below atmospheric which produces the opening of the valve. When the valve is lifted, the pressures above and below the suction valve are equalized and the suction pressure ceases to act on that particular valve.

The processes in the pressure valve occur in exactly the same manner. In the working cylinder, because of the final width of the seats, there must exist a pressure above atmospheric as is shown in equation [1]. Here again, when the valve lifts, the pressures equalize and the working pressure then prevailing no longer exerts any action on the lifted valve. In both cases, with the suction as well as with the pressure valve, the opening of the valve occurs *after* the piston passes its dead center; and not, as has hitherto been assumed, exactly when it is in dead center. The latter would involve an assumption of an infinitely narrow valve seat area, which is impossible to attain in practice. The recognition of this fact is of importance for our further investigation, viz., for the determination of conditions of quiet valve play.

In Fig. 4A, in the lower part, is given a theoretical indicator diagram of a pump (a rectangle). In this and in the following figures, *al* is the atmospheric line and *vl* the line of the absolute vacuum. The ellipse E represents piston velocities with infinitely long connecting rods and maximum piston velocity *max-v* in the middle. From equation [3] can then be calculated the maximum velocity of the fluid in the valve cross-section, *max-u*, and its square plotted in Fig. A. The other points of the curve E, the ordinates of which represent the magnitude of the stream impact acting on the valve area at any point of the piston stroke, are calculated from the equation

$$u^2 : v = \max u^2 : \max v,$$

or

$$u^2 = \frac{v.\max u^2}{\max v} \quad \ldots\ldots\ldots\ldots\ldots\ldots [4]$$

The values thus calculated, when connected by a smooth curve, give the curve E_1, which, together with the horizontal line below, encloses an area which represents the power transmitted to the valve area during one valve stroke. Its area is sectioned. The meaning of the black strip will be explained later.

In compressors, air pumps and blowers, the amount of power transmitted to the valve area is different for suction and pressure valves and in addition to that depends on the working pressure. In Fig. B in the middle is represented a theoretical indicator diagram of the compressor. After the expansion of the gas in the clearance space, the suction valve, because of the existence of the pressure below atmospheric in the working cylinder, opens theoretically at the point of intersection b of the expansion line of the clearance space with the atmospheric line *al;* the gas flows into the cylinder and its impact lifts the valve. The amount of power from the stream impact, transmitted to the valve area, is represented in Fig. B, at the bottom, by the area enclosed by the curve E_1, the vertical line at b and the horizontal line below. This area is likewise sectioned, and the meaning of the black strip will be explained later. In a similar manner has been determined the amount of power transmitted from the stream impact to the pressure valve (see Fig. B, top). The area is a section and the curve E_1 has been determined in the same manner as in the case of the pump. The points b and c shift in accordance with the working pressure of the compressor and this causes a change in the power supplied by the stream impact.

From what has been said above, it appears that the action of the stream of fluid on the valve occurs not at the dead center of the piston, with pumps, and at points b (suction valve) and c (pressure valve) with compressors, but somewhat after that. The importance of this fact will appear later.

If the magnitude of the impact stream could have been analytically computed beforehand, the dimensions of the machine and the speed at which it will run would predetermine the required loading of the valve. In the case of spring loaded valves (hence, valves without rigid limitation of the length of the stroke which is in this case elastic), the opening of the valve lags behind the dead center of the piston and occurs without shock. The shock in the valve motion can occur only when the valve hits the seat. The opening of the valve and its forward and backward motion occur

without shock. If, now, we investigate the conditions under which a free-of-shock closing of the valve occurs, we see the following: *the action of the stream of the fluid ceases exactly at the instant of reversal of the motion of the piston.* At the same instant, and hence theoretically within an infinitely short time, the valve must close, which would require a theoretically infinitely great closing force necessary for the acceleration of the mass of the valve, and this is practically impossible. Hence the closing of the valve cannot take place when the piston is at its dead point and the closing of the valve before that instant is likewise obviously out of the question. The opening of the valve without shock occurs after the reversal of the motion, since it cannot be otherwise as the action always follows the impulse.

Vice versa, a shock-free closing of the valve may be expected if it occurs after the reversal in the motion of the piston and hence not, as has hitherto been assumed or striven after, exactly at the dead point in the motion of the piston. The valve closing must occur after the reversal of the piston, since action always lags behind the impulse, and in this particular case the acting force is the stream impact. Beside, to the case of the free-of-shock valve closing applies the same rule as to all other motion which occurs free of shock—to wit, the sum of all forces or works occurring during the motion must be, at the beginning and at the end of the motion, equal to zero.

Let us now follow up from Fig. A the motion of the suction valve.[1] The valve rises with the increase in the piston velocity up to the highest point of stroke; then its stroke decreases up to the dead point in the motion of the piston. Let us imagine that the valve, at the dead point of the piston, is not yet quite closed and that between the valve and its seat there is a tiny slit. Then, at the instant of the reversal of the piston, the liquid begins to flow back through that slit, the stream impact changes its direction and helps to close the valve. Simultaneously, at the reversal of the piston, there occurs in the working cylinder a slight increase of pressure above atmospheric, since in the slit between the valve and the seat the liquid is throttled. There is, therefore, a small difference in pressure between that above and that below the suction valve, which, together with the reversed stream impact, forces the suction valve against its seat. To the negatively acting (as far as the direction is concerned) stream impact, and the closing pressure of the liquid, there must be opposed a negative load on the valve, produced by the spring. In other words, the valve must be loaded negatively (in the direction away from the seat).

If we denote the pressure above atmospheric above the valve by D, then the equation [2] for valve closing will have the following form:

$$P + G + D = P' + R + B \text{..............} [5]$$

or

$$P + G + D - P' - R - B = 0 \text{..........} [6]$$

This equation can be constructively satisfied by proper appliances, and with it can be satisfied the conditions of shock free valve closing; viz., that the sum of all forces or works at the end of the valve motion be equal to zero. How this is done may be seen from Figs. A and B.

The opening of the valve in Fig. A lags behind the dead point of the piston by the time $\triangle t$; the valve closing lags behind the other dead point of the piston by the time $\triangle t_1$. In accordance with this, the cross-sectioned area representing the work of the stream impact is reduced by the little black area having the abscissa $\triangle t$. Because of the reversed flow of the liquid, there occurs on the left side a negative working of the stream impact, which is limited by the abscissa $\triangle t_1$ and by a part of the curve E_2. The curve E_2 is the same as the curve E_1, but, in accordance with its negative sign, is curved downward. In the case of pumps handling liquids, the above applies to both valves.

In compressors, air pumps and blowers, the suction valve indicated in the lower part of Fig. B opens not at the point b, but at b_1, lagging by the time $\triangle t$, and the work of the stream impact is reduced by the amount of the black strip. The valve closing, lags behind the dead point of the piston by the time $\triangle t_1$. The negative working of the stream impact is limited by the abscissa $\triangle t_1$ and the curve E_2 and is marked in black.

The opening of the pressure valve occurs not at the point c, but lags behind it at the point c_1; the working of the stream impact is reduced by the black strip (Fig. B, upper part). The valve closing occurs behind the dead point of the piston and the negative work is marked in black (*Betrachtungen über die Bewegung der "freigängigen" Ventile*, O. Klepal, *Die Fördertechnik*, vol. 8, no. 19, p. 145, October 1, 1915, 6 pp., 8 figs., *td*).

The Holding Power of Nails

The subject of the holding power of nails in wood, and especially in hard wood, does not appear to have been sufficiently investigated and the information contained in the present abstract may therefore be of particular interest.

As the writer states, a glance at the interior of any coasting boat will show that although every nail is clinched and a length of 3 in. is allowed for that purpose, while the spread of the head barely amounts to 1 in., the waste of iron in nails alone cannot be less than from 20 to 25 per cent.

A nail holds itself in place in two ways; by friction of its sides against the wood, and when clinched, by the resistance of the clinch, which resembles a second and smaller head. Square nails are usually tapered on two sides and straight on the other two sides. The tapered sides should bear against the end grain of the wood, crushing it gradually as the nail enters. All woods, when soaked in water or when green, may be nailed with less risk of splitting than when they are dry, but there are limits to the depth that a long nail may be driven into any wood before it begins to bend. When a nail begins to bend, it shows that a hole must be made beforehand. The object of the hole is to reduce the friction so as to allow the nail to be driven without bending, but if made too large, the holding power of the nail will be reduced and clinching will be a very imperfect remedy.

If many nails of one size have to be driven, as in boat building, it is advisable to experiment on a piece of wood of the necessary thickness in order to find out the right size of hole that will avoid splitting the wood or bending the nail. When wire nails of a large size are to be clinched, they should be softened at the point by heating to redness. A wire nail is hard drawn to enable it to be driven without bending in soft woods, but it does not clinch well for this reason and therefore needs softening. To ascertain the holding power of a nail, it may be driven into an upright post, leaving the head projecting just enough to be seized by a

[1] This refers apparently to pumps handling liquids.

nail-puller. This instrument is then attached and weights added to the outer edge until the nail begins to move.

Nails that have rusted after being driven have an increased holding power, but if rusted before use they tend to make a slightly larger hole than a smooth nail. In cases where clinching would be liable to split the wood, nails may be cut and riveted over a small washer, which makes a strong and durable joint. There is also a way of clinching a nail within the wood. The point is filed away on one side to a wedge shape and then bent over the filed part until the point is level with the side of the nail. The hole is drilled to the size of the nail which is inserted with the filed surface parallel to the grain of the wood. When driven, the point takes the form of a hook and has a strong hold on the wood. The point of this nail should be heated and softened so as to facilitate the turning of the point.

Nails driven in wood that is exposed to alternate wetting and drying are liable in time to work loose because the wetting swells the wood and increases its dimensions around the nail, and as the nail is non-elastic itself, a compression is formed at the point of the nail to the amount of the swelling of the wood. When the timber dries again, the nail does not return to its original place, and if tapered, it tends to draw outward every time the wood is wet and dried. (*The Canadian Engineer*, vol. 29, no. 18, p. 519, October 28, 1915, abstract from the *Indian Textile Journal*.)

Steam Engineering

Dry Back Marine Boiler, Arthur C. Meyers

Description of an improved marine boiler designed to obtain better circulation.

To accomplish this, a tube sheet was fitted in the rear end of the furnace and the furnace connected with the combustion chamber by 4 in. tubes. It was expected that this would set up a more rapid circulation than was possible by the usual method of attaching the furnace directly to the combustion chamber. Short tests were made to determine the capacity of the boiler, but the shell was not insulated and the feed water was very low in temperature (45 deg. fahr.). The data of tests are given in Table 1. Natural draft was used, the stack being 40 ft. high and 18 in. in diameter (*International Marine Engineering*, vol. 20, no. 11, p. 511, November, 1915, 2 pp., 1 fig., *de*).

TABLE 1. TEST OF AN IMPROVED MARINE BOILER

Duration of test	1 hr. 34 m. 35 s.
Grate Surface	$8^5/_9$ sq. ft.
Heating Surface:	
Furnace crown	21 sq. ft.
19 4-inch tubes 12 in. long	18.62 sq. ft.
41 3-inch tubes 6 ft. 8 in. long	199.52 sq. ft.
Back tube sheet (effective)	3.65 sq. ft.
Total Heating Surface	242.79 sq. ft.
Ratio H. S. ÷ G. S	28.39
Average Steam Pressure by gage	95.05 lbs.
Average Steam Pressure Absolute	109.75 lbs.
Average temperature of Feed Water	45 deg. fahr.
Total water fed to boiler during test	1,845 lbs.
Total water fed to boiler per hour	1,165 lbs.
Quality of steam, per cent	97
Water evaporated per hr., corrected for quality	1,130 lbs.

Factor of evaporation, $\frac{(H - t + 32)}{966.1} = 1.212$

Where H = total heat of steam at 109.75 lb. absolute = 1,183.9.
t = average temperature of feed = 45 deg. fahr.
Water evaporated from and at 212 deg. fahr. = 1,130 × 1.212 = 1,369.56.

Tests of a 300 H.P. Superheated Steam Locomobile

The article describes tests of a 300 h.p. superheated steam locomobile plant made, first, at acceptance and then, after the plant had been in operation for two years.

The plant comprises a double-expansion superheated steam locomobile with Lentz valve gear, condensation by water injection, multitubular boiler with withdrawable fire-box and flues, and superheater built in in the smoke chamber. It has automatic powdered coal firing, operated by a small motor. The plant is used to drive a 550 volt polyphase generator of 240 kw. output, at 600 r.p.m. In order to avoid long interruptions during boiler cleaning, there has been provided a complete reserve set of fire box and flues. In addition to the measuring apparatus prescribed by law, the boiler is equipped with a superheater thermometer and differential draft gage. The draft is created by a suction fan driven by an electric motor and provided with a governor which regulates the output of the boiler in accordance with the power demand. The engine is governed by a Lentz eccentric governor placed on the crank shaft. The piston rods are provided with Lentz metal packing.

The article describes fully the method of making tests and in several tables reports the results obtained. The following are the most important data:

The steam consumption at rated output was 4.59 kg. (say 10 lb.) per h.p. While the engine is rated at 300 effective h.p., it carried during the test, in a satisfactory manner, a peak load of 429 effective h.p. for 10 to 12 minutes and the steam pressure could still be maintained with powdered coal firing. The mechanical efficiency of the steam engine was found to average over 94 per cent, while the efficiency of the boiler plant and superheater together was established by the first test to be around 80 per cent.

During the preceding two years, the locomobile was in operation on an average of 14 hours per day. The coal consumption established during this continuous operation was found to be, including all losses of firing up and removing clinker, on an average of 0.88 kg. (1.9 lb.) per effective h.p-hr. in the daytime and 1.06 kg. (2.4 lb.) at night. It must be remembered that the fuel was cheap washed powdered coal of a low heating value which makes these results appear quite favorable. It was found that when the load on the locomobile increased, the coal consumption decreased relatively; on the other hand, when in the period of August to November, 1911, because of lack of water for injection, a very low vacuum was maintained, the coal consumption went up quite noticeably. In this connection a rather curious thing was observed, viz., that the powdered coal, contrary to the case with lump coal, increased in heating value from 5 to 8 per cent with storage. (*Leistungsergebnisse bei der Abnahme und in der Praxis einer 300 PS Heissdampf-Lokomobil-Anlage, Zeits. des Oesterreichischen Ingenieur-und Architekten-Vereines*, vol. 67, no. 38, and 39, pp. 486 and 502, September 17 and 24, 1915, 8 pp., *ed*).

Boiler Inspection on Private Railroads in Russia, B. B. Sooshinski

In 1912, the technical inspection of steam boilers on private railroads was given by the government under the charge of an organization called the Society of Private Railroads for the Inspection of Steam Boilers.

Twenty-five railroads, practically the entire private railroad system of Russia, are in this Society. The latter not only inspects the boiler, but has charge of a large part of the research work connected with the boiler proper, or firing. An extensive program of boiler testing is under consideration. One of the most important elements of success of this Society is that being in the hands of private

companies, it is not deeply involved with red tape (*Nadzor za pararymi kotlami chastnykh jeleznykh dorog,* B. B. Sooshinski, *Bulletin of the Permanent Committee of the Consulting Conferences of the Agents of Various Branches of Service on Russian Railroads* (in Russian), vol. 14, no. 8, p. 872, August 1915, 4 pp., *gs*).

Strength of Materials and Materials of Construction

BEHAVIOR OF IRON AND STEEL UNDER COMPRESSION IN TESTS, H. Monden

The article describes a series of tests of considerable interest made in order to determine how the shape of the test piece affects the results of the test. Among other things, the tests are of interest because in them an attempt was made to test iron and steel under compression. In addition to this, there were carried out tests on hardness. The following results have been obtained:

1. As regards the influence of the shape of the test piece in compression tests; the tension at the yield point — σ is not affected by the shape of the test piece within the limits investigated in so far as its magnitude is concerned, but is affected in so far as its visibility is concerned. The elongation — ε is increased with the increase of the ratio of $h/\sqrt{f}$ within the limits applied from [(0.5) to 3] and with equal ratio of $h/\sqrt{f}$ they are smaller when the cross section is circular than when the cross section is square.

2. As regards alternating relations, it has been found that the tension at the yield point in compassion is equal to that in tension, or $\sigma_{+s} = \sigma_{-s}$ The stress at the yield point σ_s is materially affected by the size of the grain of the material, in such a way that, all other conditions being equal, the stress decreases with an increase in the size of the grain.

The linear relation established by Kürth, for the improvement of the yield point and Brinell hardness by the cold working, viz.: $\sigma_s = 1/c\ (H - H_o)$ holds for the types of wrought iron and steel used for technical purposes in that the constant $1/c$ remains of the same magnitude for all kinds of wrought iron, while the constant H_o is a function of the size of grain in that it decreases with the increase of the latter (*Ueber das Verhalten mehrerer Eisen- und Stahlsorten beim Druckversuch,* Herbert Monden, *Stahl und Eisen,* vol. 35, nos. 40 and 41, pp. 1022 and 1052, October 7 and 14, 1915, 11 pp., 10 figs., *eA*).

BINARY ALLOYS OF ALUMINUM, H. Schirmeister

The article describes an interesting series of tests on binary alloys of aluminum.

In so far as good rolling and normal annealing is concerned, zinc is probably the metal which produces by far the greatest improvement in the mechanical properties of aluminum, although the strongest alloys, containing from 25 per cent to 28 per cent of zinc, depart from the very low specific weight. Further, the higher percentages of zinc materially lower the melting point and strongly affect the resistance of the alloy to weathering conditions. The next strongest alloy is that of aluminum with 5 to 6 per cent magnesium, but this alloy has only a low resistance to chemical action. In the third place stand copper alloys, which attain the greatest mechanical strength when the addition of copper is about 3 per cent. It resists atmospheric reactions very well and has still quite a high melting point. From a practical point of view, therefore, this system is the most available and the most widely used. Next to this come the alloys of aluminum with silicon, nickel, cobalt and iron. Of the rare metals only chromium produces a really material improvement, while manganese, vanadium and molybdenum are also of certain advantage. With all other metals the advantage obtained is so insignificant that it is hardly worth while to add them at all.

The methods of production and machining of the alloys have also been investigated. With proper methods of melting, the difference between the results obtained with the use of graphite or clay crucibles, as well as the various temperatures of pouring, are not substantial. On the other hand, a rapid rolling at high temperatures produces, as a rule, considerable improvement in the elongation obtained, while a cold working which is as thorough as possible, produces a not inconsiderable improvement in tensile strength even after annealing. The resistance of the alloy to chemical actions appears to be somewhat affected by the mechanical and heat treatment of the metal, but it depends essentially on the chemical composition of the alloy. It can be determined with certainty only by thorough tests of long duration made under conditions approximating those of the actual working of the alloy.

As far as casting in molds is concerned, shrinking has also a great importance, since the less is the tendency of the alloy to shrink, the better adapted it is for casting. In general, the author comes to the conclusion that material for casting must be more highly alloyed than that for rolling.

Finally, he found for all aluminum alloys, without exception, that additions of very small amounts, such as tenths and hundredths of one per cent, did not affect either the mechanical or chemical properties of aluminum. This is only natural, since even what is known in the trade as pure aluminum contains usually about 1 per cent or more of "impurities," which are nothing but alloyed elements (*Zur Kenntniss der binären Aluminiumlegierungen,* Hermann Schirmeister, *Stahl und Eisen,* vol. 35, nos. 34 and 39, pp. 873 and 996, August 26 and September 30, 1915, *e*).

Miscellanea

LARGE LAUNDRY FOR HANDLING SHIP WASHING, Wm. Scholz

Description of the large laundry installed by the Hamburg-America line, at Kuhwärder Harbor (leased by that Company).

The necessity for such a laundry was created just before the war by the construction of ships of the *Imperator* type, having a passenger list of more than 4500 and making the trip between Hamburg and New York in from five to six days. During such a trip, both ways, up to 30,000 kg. (say, 65,000 lb.) of wash accumulates, and this has to be taken care of in a very short period of time, between the arrival and departure of the steamer at Hamburg, unless a very large extra stock of linens be kept. To this was added the fact that sending the wash to a private laundry inland involved a lot of troublesome custom formalities. It was decided by the company, therefore, to install a plant of its own which would take care not only of the washing proper, but also the removal of spots and the repair of the linen. That there would be sufficient business for the plant was shown by the fact that it would be called upon to take care of the washing for more than 200 seagoing vessels.

In view of the fact that ships of the *Imperator* type can-

not come in close to the shore in the harbor selected for the site of the laundry, the washing has to be delivered by lighter, which required particular installations to make the handling of it, in and out of the lighters, convenient. For the loading and unloading at shore, a special loading bridge of reinforced concrete, with the exception of the roof, was built. The laundry delivered from the land side is taken in at the east wing of the building and delivered directly to the reception and weighing room. That taken in from the water side is delivered in sacks, weighing 30 to 40 kg. (66 to 88 lb.), to the loading platform in batches of 15 to 20 sacks each, by means of a portable electrically driven loading crane. From the platform, it is delivered inside the building, where it is sorted and weighed.

The washing machinery is not described in great detail; some features, however, are of interest. In order to reduce the number of attendants at the steam mangles, a special device designed by the author of the article, was introduced for handling the washing put in; this device is particularly convenient for mangles handling large numbers of pieces of the same type, such as handkerchiefs, napkins, etc. (In this connection it is mentioned that a steamer of the *Imperator* type brings, after a return trip, something like 40,000 napkins).

The usual output of the laundry for a nine-hour working day, is 8000 to 10,000 kg (17,600 to 22,000 lb.) of fully washed and packed linen. In order to prevent deterioration of large and valuable linen, each piece, which during the sorting process is found to be injured, however slightly, is delivered immediately to a repair shop, equipped at present with 20 electrically driven sewing machines.

The washing machines, centrifugals and steam mangles, are illustrated in the article. The water supply and ventilating systems are briefly described (*Die Grosswäscherei der Hamburg-Amerika-Linie in Hamburg-Kuhwärder,* Dr. Wm. Scholz, *Zeits. des Vereines deutscher Ingenieure,* vol. 59, no. 40, p. 815, October 2, 1915, 7 pp., 17 figs., *d*).

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF CIVIL ENGINEERS

Proceedings, vol. 41, no. 8, October 1915, New York City.

THE AUTOMATIC VOLUMETER, E. G. Hopson

The paper describes an apparatus intended to gage the flow of fluids by the collection of a proportionate part of the flow or its equivalent, in a small vessel where it can be readily measured at any time. The apparatus is arranged in such a way that the pressure head under which the discharge into the collecting vessel takes place, is at all times equivalent to, or a constant ratio of, the velocity head of the liquid or gas being measured. The name volumeter is somewhat of a misnomer since actually it is the velocity or pressure due to velocity that is its operating force.

The volumeter operates by the velocity head of the fluid which is being measured. Not only is velocity head communicated, but a very small proportion of the actual flow is diverted into the apparatus, though this proportion is so small and the velocity of flow in the diverting pipe so insignificant that there are no appreciable losses of head by friction in the pipe to disturb the basic plan of operation by velocity head. A return pipe from the volumeter to the stream carries away the surplus liquid created by the influent flow. The apparatus may be attached to a pipe with communication through a Pitot tube, or at submerged orifices, or on a short pipe or box flume of varying cross-section, or in several other ways. The method must only be consistent and be such that the head communicated to the volumeter is a constant factor of the velocity head, which later is the essential condition.

The most difficult feature of the apparatus to work out was an arrangement whereby the head under which the interior jet operates is kept identical with or a constant factor of the velocity head of the stream. It is necessary for the apparatus to be absolutely automatic and its response to the most minute changes of head to be immediate and of the most delicate sensitiveness. It works in the following manner: The influent entering the upper part of the lower vessel (Fig. 5) creates a pressure at its point of entry equal to the sum of the static and velocity heads of the entering water, the frictional losses in the influent pipe and orifice being negligible, due to their great size and the very low velocities in them. The lighter medium (liquid or gas) con-

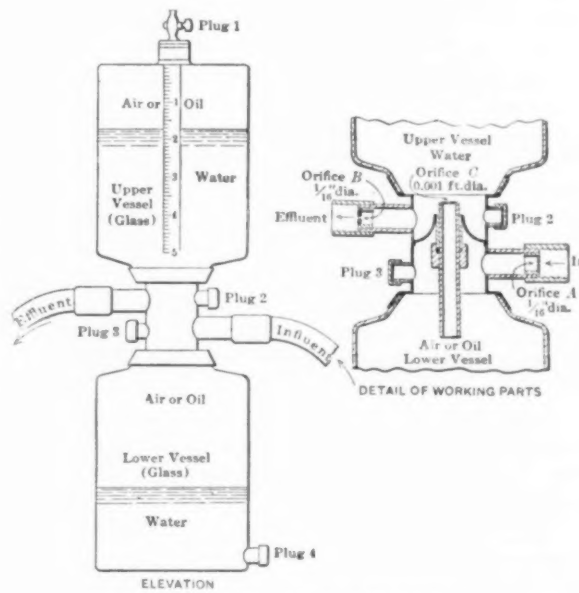

FIG. 5 AUTOMATIC VOLUMETER

tained in the lower vessel is thus put under pressure. The upper vessel is connected with the flowing water in such a manner that only the static head is communicated to it. The flow through the small orifice connecting the two vessels, therefore, is for all practical purposes that due to the velocity head or a constant factor of the velocity head only.

The operating details are shown in the figure. The influent enters the lower vessel or container at its upper part through an orifice at *A*. The pressure communicated is due to the static head of the water being measured plus the velocity head due to the rate of flow. This pressure is communicated to the medium (oil, air or whatever may be used) in the lower vessel and in turn is transmitted through the medium to the lower side of the point of connection with the upper vessel at the orifice *C*. The water in the effluent pipe is only under the pressure due to the static head of the stream being measured. This pressure is communicated directly through the water in the lower part of the upper vessel down to the upper side of the orifice, *C*. When there is no velocity, the static head of the stream is communicated to both the upper and lower sides of the orifice, *C*, and there

is no movement. Whenever there is velocity the corresponding head is at once communicated to the lower side of the orifice C; the balance of forces is overthrown and a movement is started proportioned to $\sqrt{2g}$ multiplied by the square root of the velocity head less what head is required to overcome the various frictional resistances.

In order to work out this device, the coefficient of flow through very small orifices had to be established and experiments along these lines revealed totally unexpected conditions. It has been necessary to deal here with flow through orifices not exceeding 0.001 to 0.004 ft. in diameter, and apparently with these small openings, the ordinary laws of flow did not apply with the lower heads. Another marked difference between results obtained with these small orifices and with the larger ones is that apparently the former have distinctly greater coefficients under certain heads than the latter.

In addition to experiments with water, runs were made using oil. It was necessary to find an oil having a viscosity which did not change very materially under changes of temperature, such as would be encountered in a water measuring device under working conditions. The oils most nearly approaching these conditions were kerosene, a petroleum product known commercially as white neutral oil, and another petroleum product known as glymol (a thick clear oil, used generally for medicinal and surgical purposes). From experiments, it was found that a very appreciable force was necessary to break the seal of surface tension and induce a flow between the different media through the small orifices required on this apparatus. A study of the curves of coefficients of flow seems to indicate clearly that the reduction of the coefficient with the small orifices under low heads is due largely to some obscure retarding force, such as surface tension, which actually absorbed a portion of the operating or velocity head applies and is, to a considerable extent, a constant in itself.

The principal sources of error in this device are temperature changes affecting the specific gravity of the measuring medium or its bulk. Changes in the air density will also influence the results to a small extent. Some of the causes of error can be avoided or obviated. Others are inherent but tend to a considerable extent to balance and neutralize each other. The apparatus must be set by one who understands the principles of its operation, but its further operation is so simple and automatic that any ditch rider of average intelligence will be able to reset and read it each day or whenever necessary (17 pp., 9 fig., *ed*).

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Journal, vol. 22, no. 1, October, 1915, New York City.

TESTS ON THE RECIRCULATION OF WASHED AIR, PROF. G. L. Larson

Recent investigations have shown that what is known as bad air is caused by neither depletion of the amount of oxygen present nor excess of carbon dioxide, and symptoms of discomfort in a poorly ventilated place are due mainly to the physical conditions of the air with respect to temperature, humidity and movement, and not to its chemical properties. The present paper describes tests (Wisconsin High School), undertaken in order to ascertain the advisability of installing similar systems in the future buildings of the University of Wisconsin.

The high school building is heated partly by direct radiation and partly by indirect, the system being of the one-pipe direct steam type throughout. Ventilation of the building is provided by a blast fan discharging through ducts on the ceiling of the basement that rise to the rooms to be ventilated and enter the rooms near the ceiling; special systems of ventilation are used for the toilet rooms and the chemical laboratory. The paper describes fully the apparatus and methods used.

Considerable difficulty was experienced in determining the true volume of air entering the rooms. Readings were taken at the duct leading to the gymnasium. First a series of readings were taken at the register and then the register was removed and another set of readings taken, holding the anemometer horizontally in the vertical duct leading to the room. The readings at the register showed an average of 482 ft. per minute and those in the duct showed an average of 810 ft. per minute. The registers are unusually heavy and the net area of the particular size in the gymnasium is only 96 per cent of the area of the vertical duct leading to the room. Therefore the velocity through the register should check very closely with the velocity in the duct, which was, however, very far from being the case. These and other tests showed conclusively that the register deflected air currents inside and gave velocity values which were very much lower than the actual values, so that the readings taken with the anemometer placed against the register are absolutely unreliable.

The author comes to the following general conclusions:

1. The tests show that it is both unnecessary and uneconomical to supply large volumes of air to obtain good ventilation.

2. That 15 cu. ft. of air per student would be ample, providing it enters the room at a fairly high velocity and carries the proper amount of moisture.

3. With humidity ranging from 50 to 70 per cent, the occupants of the rooms are perfectly comfortable at a temperature of 65 deg. or even less.

4. With humidity of about 60 per cent, the air can enter the rooms at a temperature of 60 deg. without creating any discomfort; in fact it seems to give life to the air and aids in the efficiency of ventilation.

5. Carbon dioxide content as high as 20 parts in 10,000 does not have a bad effect upon the ventilation.

6. Ventilation by recirculation is both efficient and economical. At the end of a year's run the teachers are almost unanimous in their praise of the system.

7. With a recirculating system such as this, it requires from 40 to 50 per cent less steam to heat the building, while the fan is in operation, than would be required if the air was drawn from outdoors for the same length of time.

8. Air movement keeps the temperature uniform in various parts of the room and decreases the amount of steam

required for heating. The tests show a minimum saving of about 8 per cent due to this air movement; this would be true whether the system is a recirculating one or otherwise.

9. The air washer absorbs a considerable amount of the carbon dioxide contained in the air passing through it.

10. The air washer is apparently quite efficient as a dust remover but it does not remove bacteria from the air when the washer water is recirculated. The tests show that it actually supplies bacteria to the air under such conditions.

11. In spite of the poor showing of the washer, the air entering the rooms carries no more bacteria than outside air when the relative velocities in which the plates were exposed are taken into account.

Further tests are being planned (41 pp., 11 figs., *de*).

CANADIAN SOCIETY OF CIVIL ENGINEERS

Transactions, vol. 29, part 1, January to June 1915, Montreal.

Movable Dams, H. B. Muckleston
Lethbridge Sewage Disposal Works, A. C. D. Blanchard
Jordan River Power Development, C. A. Lee
Edmonton's Tunnel Sewer System, A. J. Latornell
Tests on the Shearing Resistance of Reinforced Concrete Beams, E. Brown, H. M. MacKay, and C. M. Morssen (abstracted)

TESTS ON THE SHEARING RESISTANCE OF REINFORCED CONCRETE BEAMS, E. Brown, H. M. MacKay and C. M. Morssen.

The paper describes the results of tests carried out by the authors in connection with the work of a committee of the Society, on concrete and reinforced concrete. The authors state that the formulae derived (for the allowable shearing stress intensities and for computation of stirrups), are admittedly inadequate as a representation of the actual conditions in a beam, but, used in conjunction with experimental data as a means of fixing allowable unit stresses, they may serve as a satisfactory means of estimating the amount and disposition of steel required to reinforce the beams adequately against shears.

Four distinct lines of experimentation were followed, to determine the behavior of beams reinforced with (*a*) straight rods only on the tension side; (*b*) combination of straight and bent rods, the latter assisting in carrying the tension due to shearing; (*c*) straight rods as in (*a*) assisted by vertical stirrups of different spacing, and (*d*) a combination of straight and bent rods as in (*b*) assisted by vertical stirrups of different spacing.

It was found, broadly speaking, that the beams in which some of the main reinforcement is bent up diagonally deflect less than corresponding beams in which all of the main reinforcement is straight. This is a definite action of the diagonal rods. The effects of different stirrup spacings on the deflections are irregular. In many cases, the cracking of beams was checked noticeably by the stirrups and marked increases of ultimate strength resulted by adding stirrups to beams having straight rods only as tension reinforcement. Sometimes a crack would extend directly through the body of a beam so as to enable an observer to see through it, but the stirrups held the two elements of the beam and prevented collapse.

The general effect of stirrups was to raise the ultimate strength very noticeably and when spaced 4 in. apart, shearing failure was eliminated. Shear failure may also be obviated by bending up some of the tension reinforcements in a diagonal direction. The diagonal bending up of rods also greatly increases the ultimate strength and the addition of stirrups to the beams having such diagonal rods, affects the manner of failure rather than the load at failure.

The tests were carried out mainly with reference to the clause of the specification adopted by the Canadian Society of Civil Engineers (clause 28) (20 pp., 2 figs., *e*).

COLLEGE OF ENGINEERING, KYOTO IMPERIAL UNIVERSITY

Memoirs, vol. 1, no. 4, August 1915, Kyoto, Japan.

ON LEONARD CONTROL APPLIED TO MINE HOISTS, Risaburō Torikai.

The paper considers the load diagram, the gradual rating and the theoretical durations of acceleration and retardation of a direct current mine hoist motor controlled by the Leonard system, without entering upon discussion of the equalizing apparatus. It is to a certain extent an extension of the paper by Wilfred Sykes on large electric hoist plants in the Proceedings of the American Institute of Electrical Engineers, Vol. 29, Part I, 1910.

The paper gives the general equations of the resisting moment of hoist as well as equations from which may be found the economical relation between acceleration and retardation. An equation is given from which may be determined, though with some difficulty, the capacity of the hoist motor, taking iron losses into account. The subject is treated mathematically. (33 pp., 3 figs. *m*).

ENGINEERING SOCIETIES OF PURDUE UNIVERSITY

The Purdue Engineering Review, vol. 15, no. 8, 1915

Flood Protection in Indiana, Professor W. K. Hatt
Tests of Standard and Clasp Brake Rigging for Passenger Train Service, E. F. Lickey (abstracted)
Notes on the Construction of a 48-inch Re-inforced Concrete Sewer, Albert A. Chenoweth
Rope Transmission, E. M. Carver

TESTS OF STANDARD AND CLASP BRAKE RIGGING FOR PASSENGER TRAIN SERVICE, E. F. Lickey

The paper is mainly an extract from a report submitted to the officials of the Lake Shore and Michigan Southern Railway by the engineers who carried out these tests.

Several years ago, the L. S. and M. S. Railway had, in common with other roads, a great deal of trouble with skid flat wheels, caused by the heavy braking pressures necessary on account of the increased weight of equipment and aided by the cold winter weather and frosty rails. The clasp type of brake rigging was proposed as a means of overcoming the trouble and in order to determine what advantage, if any, the clasp brake arrangement possessed over the standard foundation brake rigging, a series of tests were made near Toledo, O., by a group of engineers representing the Westinghouse Air Brake Company and the L. S. and M. S. Ry. The track was equipped with a chronograph and the necessary circuit breakers. The necessary speeds were obtained by running the train back several miles distance, depending upon the speed desired and then making the run toward the tripping point; at the trip, the engine was cut loose from the train and the latter was braked by making the desired brake pipe reduction. The speed was judged from a Boyer recorder on the engine and by experience. Brake cylinder pressures were recorded by indicators attached to them.

Under like conditions of standing piston travel and brake pipe pressure, the clasp brake cars stopped slightly shorter than the standard brake cars. It was found that with approximately 150 per cent nominal emergency braking power on the clasp brake cars and 170 per cent nominal emergency braking power on the standard braking cars, the difference in running piston travel with the two equipments will be such that the actual percentage of braking power realized will produce practically the same stop with each type of rigging.

The stops with the three clasp brake cars vary through a considerably narrower range than that for the three standard brake cars with the same percentage of braking power, which indicates that the clasp brake insures a greater uniformity of brake action. A single car emergency test made to find out if there was any greater variation in rates of retardation on individual cars with the standard brake than there was on cars with the clasp brake, indicated that on the basis of the same amount of braking power, the individual cars vary but little and approximately the same amount for both types of rigging.

Comparative tests of standard brake cars with and without emergency reservoirs have shown that there was an average increase of about 166 ft. in the length of stop when the emergency reservoirs were cut out, which is, however, only the difference between the best and the poorest stops by the standard brake cars with the emergency reservoirs cut in. Practically the same relation between the emergency stops with emergency reservoirs in and out was found to exist with the clasp brake cars as with the standard brake cars.

With the standard brake rigging, it was observed that the high pressure exerted by the single shoe on one side of the wheel, tilted the axle bearing brasses sufficiently to lift one side of the brass a considerable distance away from the journal, so that a wide space was opened for waste to be caught between the brass and the journal when the brake was released; these effects were noted in service applications of the brake as well as in emergency applications. With the clasp brake arrangement, however, nothing of this kind was noted.

No record of the amount of brake shoe wear, by weighing of the shoes, was taken. It was noted, however, that the temperature of both wheels and brake shoes with clasp brake cars was uniformly much lower than with the standard brake rigging. On the whole, the conclusion was arrived at that the clasp type of brake was the proper design for use on heavy passenger equipment (7 pp., 2 figs., *e*).

SOCIETY OF CHEMICAL INDUSTRY

Journal, vol. 34, no. 19, October 15, 1915, London.

Vulcanization Experiments on Plantation Para Rubber. The Cause of Variability, B. J. Eaton and J. Grantham.

The writers call attention to the controversial statements made during the last two or three years, concerning variability in plantation Para rubber. While some manufacturers claimed that the variation is considerable, even in the case of "First latex" rubber when compared with fine hard Para, or first grade of wild Para rubber, leading rubber technologists maintain that the best grades of plantation Para rubber, especially sheet, are superior to fine hard Para. The writers, on the basis of an extensive series of experiments made at the testing laboratories of the Department of Agriculture, Federated Malay States, claim that both opinions may be taken as correct and are not necessarily contradictory.

They come to the following conclusions:

(1) Considerable variation occurs in plantation Para rubbers, even in the case of "First latex," both among rubbers from the same estate and from different estates.

(2) This variation is connected principally with the behavior of the rubber on vulcanization, i. e., its rate of cure and not in respect to its strength, elasticity, and general mechanical properties, especially in the case of properly prepared "first latex" samples.

(3) If the rate of cure be known or ascertained under specific conditions, vulcanized rubber having similar chemical properties can be made from all good samples of "first latex" rubbers.

(4) A difference in mechanical properties does exist, even among so-called first quality rubbers, but these differences are greater between high and low grade plantation rubbers; some rubbers never attain the maximum mechanical properties reached by others, whatever period of cure is adapted. These differences, in the case of the "first latex" rubbers, however, are not so important to the manufacturer as the differences in rate of cure, and are not of the same order. Indeed, the remarkable uniformity in type of curve points to the fact that the variation of mechanical properties in our samples, at any rate, is of an accidental nature, for at points below the breaking point the mechanical properties are the same.

(5) The rate of cure is due to the presence of some non-caoutchouc substance in the latex, possibly protein or some other organic constituent, or to some degradation product derived from these substances, which acts as a catalyst, and accelerates the rate of cure.

(6) This substance may be already present in the latex, and its amount in the raw rubber determined by the mode of preparation and coagulation, or it may be subsequently formed in the latex by decomposition and taken up by the rubber in variable quantity, according to mode of preparation, or, alternatively, it may be formed in the coagulum in variable quantity, depending on the amount of serum (or moisture) left in the coagulum or the presence of preservatives which hinder or prevent its formation. The alternative theories await investigation.

(7) Smoking, removal of excessive serum in the washing and machining processes, and preservatives are among the artificial factors which either hinder the formation of this substance, or, if it already exists in the prepared rubber, partially destroy it.

(8) The catalytic substance is probably not affected greatly by the heat, since in the process of mixing and vulcanization, the rubber is subjected to relatively high temperature. Whether heat destroys it or prevents its formation in the latex or freshly coagulated rubber awaits investigation.

(9) The rate of cure of a rubber under specific conditions is not indicated in any way by the apparent mechanical or any other apparent properties of the raw material, hence the worthlessness of the present methods of valuation of rubber.

(10) *Caeteris paribus*, a manufacturer probably prefers a rapidly curing rubber, since it represents economy in heat, labor, and time costs, and secondly, a rubber which cures

rapidly is said to have better keeping qualities after vulcanization.

(11) Uniformity between "first latex" rubbers from different estates will probably be very difficult of attainment with present methods, owing to the number of factors involved, but should not be so difficult among such rubbers from the same estates.

(12) Two alternatives are suggested: (a) The issue of certificates giving correct rate of cure and mechanical properties at this cure; (b) The attainment of more uniformity by the method suggested in this paper and elsewhere, in which rubber from latex collected during a series of days forms part of one ball or block, which may be described as the method of averages (11 pp., 5 figs., *epA*).

UNIVERSITY OF ILLINOIS

Bulletin, vol. 12, no. 47, July 26, 1915, Urbana, Ill.

INFLUENCE OF TEMPERATURE ON THE STRENGTH OF CONCRETE, A. B. McDaniel

The purpose of the bulletin is to furnish information based on experiments to determine the influence of temperature on the attainment of strength in concrete. The author comes to the following general conclusions:

First. Under uniform temperature conditions, there was an increase of strength with age within the limits of the tests. For any temperature the rate of increase decreases with the age of the specimen; and this rate of increase is less correspondingly at the lower temperature conditions. For the specimens tested, under normal hardening temperature conditions of from 60 to 70 deg. fahr., the compressive strength of the concrete subjected to a uniform temperature at the ages of 7, 14 and 21 days may be taken as approximately 50 per cent, 75 per cent and 90 per cent of the strength at twenty-eight days, respectively. For lower temperatures the percentage values are less, and for higher temperatures the percentages are higher. The relation between the percentage values at the age of 7, 14, 21 and 28 days is nearly the same for temperature conditions from 30 deg. to 70 deg. fahr. However, the values for the lower temperatures should be used with caution.

Second. Concrete which is maintained at a temperature of 60 deg. to 70 deg. fahr. will at the age of one week have practically double the strength of the same material which is kept at a temperature of 32 deg. to 40 deg. fahr.

Third. Figs 6A and B may be used to determine the representative strength of concrete similar to that used in these tests, for various temperature conditions and for ages up to 28 days. These diagrams may be used with a fair degree of approximation to ascertain the relative strengths which concrete of ordinary practice may be expected to attain at the different temperatures. It should be noted that generally in this investigation the specimens were stored under temperatures which were nearly uniform during the whole storage period. The tests summarized in Fig. A and B cover a wide range of temperature conditions, the average temperature varying from 20.4 deg. fahr. to 90.6 deg. fahr., and are fairly consistent; and hence it is believed these values are sufficiently accurate to furnish suggestive information which may be useful in determining the time when forms may be removed and loads applied. The results accord with the well-known effect of freezing and thawing upon green concrete (24 pp., 15 figs., *e*).

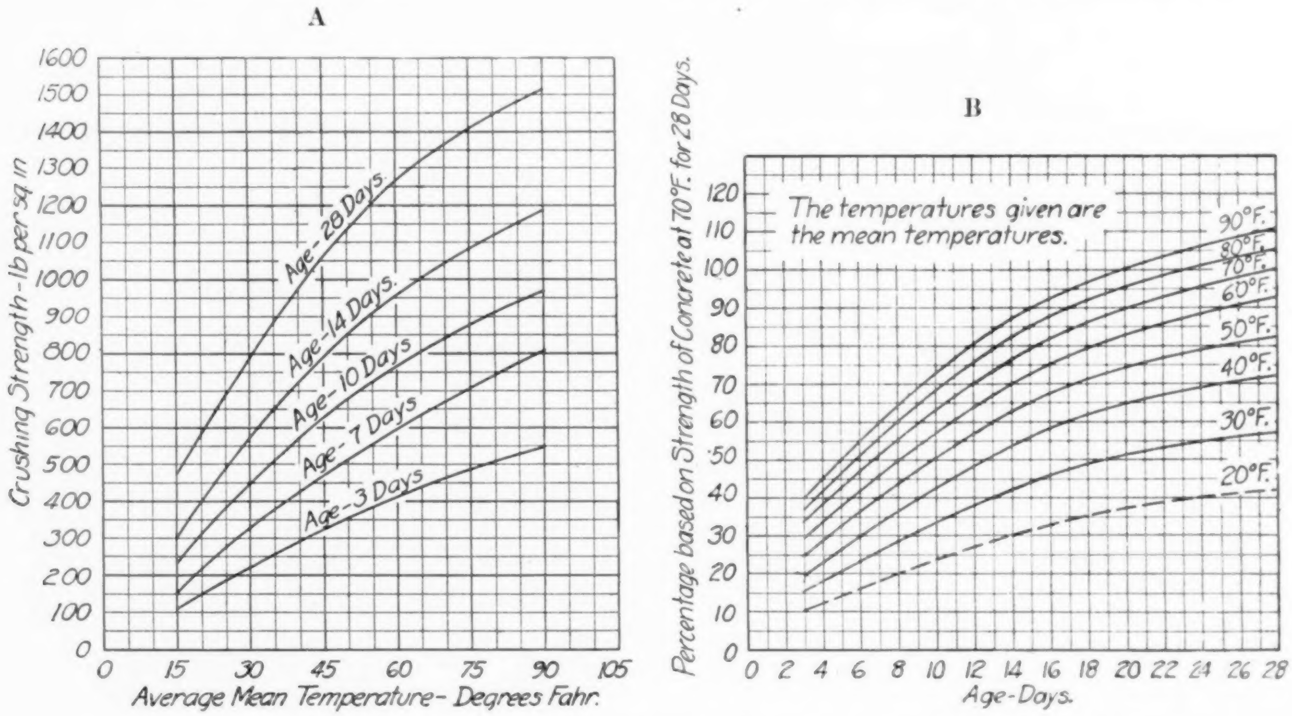

FIG. 6 A, RELATION OF STRENGTH TO TEMPERATURE FOR DIFFERENT AGES; B, PERCENTAGES OF STRENGTH FOR DIFFERENT TEMPERATURES

CLASSIFICATION OF ARTICLES

The various articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of exceptional merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

MEETINGS

CINCINNATI, OCTOBER 21

The regular October meeting of the Cincinnati Section of the American Society of Mechanical Engineers was held as a joint meeting with the Engineers' Club of Cincinnati, on October 21. The speaker was O. Monnett, of the American Radiator Company, formerly Associate Editor of Power, and Chief Smoke Inspector of the city of Chicago. His remarks were based upon a very fine collection of lantern slides which had been accumulated during his efforts to eliminate smoke in Chicago. Mr. Monnett began by describing and showing the dutch oven construction for hand-fired furnaces under boilers. He reviewed the experiences with this form of setting before it was abandoned, and showed that its failure to burn coal smokelessly, or nearly smokelessly, was due to a rapid distillation of the volatile matter in the coal from the intense heat of the top arch. The speaker then took up in detail the various furnaces for hand firing that were developed in Chicago until the latest form of double arch bridge wall furnace was devised. The speaker mentioned the fact that this furnace had been quite successful in Chicago, and that it had been adopted by the city of Cincinnati for burning of high volatile fuels.

Mr. Monnett said that the chief factors in smokeless combustion are temperature, mixture, time, and oxygen. In other words, that there must be present sufficient oxygen to burn volatile hydrocarbons, that there must be an intimate mixture of the oxygen and hydrocarbons, that there must be sufficient time for the burning before the comparatively cool surfaces of the boiler itself are touched by the gases.

After a very thorough discussion of the principles underlying the design of hand-fired furnaces for high volatile coals, Mr. Monnett showed slides illustrating the application of the most general principles to various forms of mechanical stokers. He stated that the chain grate stoker was very satisfactory for the non-caking coals that are generally used in Chicago, while experience has shown that the non-caking coals, coming to the Cincinnati market from West Virginia, Pennsylvania, Kentucky, and other states, were not readily burned with high efficiency on the chain grate. He also referred to a careful study of heatings of various boilers, the measurements having been taken from hundreds of tests.

The presentation of the paper was followed by a vigorous discussion. Among those taking part in the discussion were A. G. Hall, J. J. Nelis, J. T. Faig, Members Am. Soc. M. E., and the Chief Smoke Inspector of the city of Cincinnati. There were about 100 members and guests present.

PHILADELPHIA, OCTOBER 26

The first regular meeting for the coming season of the Philadelphia section of The American Society of Mechanical Engineers was held at the Engineers' Club on Tuesday evening, October 26. The paper was by J. A. Steinmetz, Mem. Am. Soc. M. E., and President of the Pennsylvania Aero Club. The paper reviewed in an interesting manner the development of the aeroplane in France and Germany and finally described, with lantern slide illustrations, methods of aeronautical warfare. The speaker said that as well might a blind man go forth to battle as an army without its aerial eyes. The old days of cavalry reconnaisance and of surprise turning movements of the flank are impossible because of the all-seeing eyes of the flying man high in the cloud land.

The French and German aeroplane fleets of today were built largely by public subscription. In February 1912 the potentiality of the air service was demonstrated in France, but the French government failed to allow the appropriations necessary for its development. But in every part of France the people, rich and poor, old and young, united their efforts with the press and various organizations to give France a large aerial fleet. A huge public subscription was raised which gave France 208 aeroplanes, 62 landing stations for aeroplanes and 75 trained aviators. The interest created was tremendous and the government took up the matter until in 1914 the army possessed 1200 aeroplanes and 28 dirigibles.

Germany's aeroplane fleet was built almost entirely by public subscriptions, started by the Aerial League of Germany in 1912. As in France, this popular movement led to action by the government and the Reichstag provided a plan for an expenditure of 35 million dollars for military aeronautics during the five years following. In 1914 the inducements offered by the Aerial League led to the breaking by German aviators of all the world's flying records. For instance, continuous flights of nearly 22 hours were achieved, a distance of 1336 miles was covered in one day and an altitude of 21,654 feet was reached.

The author held that just as the people in every part of France and Germany had united their efforts for the advance of aviation, so here in America the same could be accomplished, for "surely we Americans with our greater resources can do even better."

ST. LOUIS, OCTOBER 26

Under the auspices of the St. Louis Section of the Am. Soc. M. E., the Engineers' Club, together with the associated local societies including the American Society of Civil Engineers, the American Institute of Electrical Engineers, and the American Society of Engineering Contractors, held a meeting in honor of the President and guest of the Am. Soc. M. E., Dr. John A. Brashear, on October 26 and 27. Dr. Brashear was met at the station by the Executive Committee of the Am. Soc. M. E. and William Haren, a personal friend of Dr. Brashear's, and owner of the first Brashear lens ever brought to St. Louis. After a visit through the St. Louis park system and to the Art Museum, Dr. Brashear was escorted to the City Club for lunch after which he gave a short address entitled, "Reminiscences." Dr. Brashear's talk touched on some of the most prominent facts that astronomical work has brought forth in the last century, and was interspersed with many interesting personal anecdotes. Dr. Brashear was personally a stranger to most of the St. Louis Section, and had been heralded as a maker of scientific apparatus and an astronomer, and the audience was delighted to find him also one of the most human of human beings.

The afternoon was spent in showing Dr. Brashear parts of the old section of St. Louis including the famous Shaw's Garden. At 6:30 an informal dinner was served at the Washington Hotel, at the close of which Dr. Brashear spoke a few words which left the audience with a feeling that in studying the stars and their distances into the millions of light years he was also studying divinity and humanity in the largest way. Following his remarks, Prof. Nipher gave a

short talk on the infinitely small divisions of the atom at which he was working which signified that he is studying the same vast subject as Dr. Brashear at the opposite extremity of dimension.

At eight o'clock, 1200 engineers of St. Louis with their guests assembled in the Soldan High School and listened to Dr. Brashear's illustrated story of the great telescopes of the world and the discoveries made by their use.

The next day Dr. Brashear addressed the students at Washington University at chapel and at a luncheon tendered him by the University.

PROVIDENCE, OCTOBER 27

A meeting of the Providence Section of Mechanical Engineers was held in Brown University on October 27. The special feature of the meeting was an address, fully illustrated, by Arthur W. Dow, Mechanical Engineer of the Dow & Smith Company of New York, on the subject of Modern Highway Pavements. Invitations to the meeting were sent to city and state authorities both in Rhode Island and southern Massachusetts, and there were a great many representatives from these authorities present.

BUFFALO, NOVEMBER 3

At a meeting of the Engineering Society of Buffalo, held on November 3, Mr. Hunt, Chief Engineer of the Packard Motor Car Company, gave a paper on the Multiplicity of Cylinders. He dwelt on the engineering relations of balance, and inertia forces, on the four, six, eight, and twelve cylinder gasoline engines. He came to the conclusion that the last is the most satisfactory. There were nearly 400 members and guests present.

NEW YORK, NOVEMBER 9

A meeting of the New York local section, at which John J. Swan, Mem. Am. Soc. M. E., presided, was held on November 9.

Under the title, An Investigation of Gas Producer Power Plants in New York City and Vicinity, Charles Meigs Ripley, in the paper of the evening, reported the results of a census of opinions obtained from owners of private gas plants in this city regarding repairs, labor, depreciation, satisfaction with their plants or otherwise, and future installations.

The author had tabulated these data, as well as sizes, costs, loads, fuels, attendance, and ages of the plants, and presented it in the form of charts, the plants represented in which he discussed in considerable detail.

The paper was discussed by John H. Norris, Mem. Am. Soc. M. E., H. G. H. Tarr, E. Rathbun, Mem. Am. Soc. M. E., and Wm. T. Price, Mem. Am. Soc. M. E. Both paper and discussion are published in this issue of The Journal.

MILWAUKEE, NOVEMBER 10

An interesting meeting of the Milwaukee Section was held on November 10, at which about 130 members and guests were present. At the meeting, Robert Cramer, Mem. Am. Soc. M. E., gave a paper on High Pressure Boiler Design:

High steam pressures at the present time are an established fact. A steam turbine of 20,000 kw. capacity to work under 600 lb. steam pressure is in the course of construction and is to be installed, together with boilers capable of giving this pressure, in a large power house.

The theoretical comparisons referring to the advantages of high steam pressure form the subject of a paper to be delivered by the author at the Annual Meeting of the Am. Soc. M. E. in New York City on December 8. This matter is therefore referred to very briefly here.

In the gradual development of practice in steam engineering the limit of temperature has been apparently reached with 600 deg. fahr. The limit of pressure, however, has not been reached with the current practice of slightly over 200 lb.

The justification for the introduction of high steam pressures lies in the gain in fuel economy while the practical difficulties lie in the structural parts of the steam boiler. It is necessary to retain the essential characteristics of circulation such as are found in water tube boilers at the present time, because these characteristics make it possible to handle the regulation of the fire and the feed independent of each other. The question whether circulation can be obtained in a boiler constructed entirely out of tubes is therefore of prime importance.

The characteristics of the water tube boiler, provided with steam drum and water level, are compared with that of another type of boiler made of tubes only. The point is brought out that with the latter type of boiler, steady circulation is obtained.

In realizing this point in practice, the boiler is built up of a number of so-called *Sections,* each section consisting of two headers which are connected by a number of horizontal tubes. The headers are connected to a common steam drum and a common water drum. The difficulties which arise from the operation of a number of sections in groups are illustrated, and means for meeting them are described.

The advantages of this sectional construction are also apparent in practical operation. It is possible to remove any section at any time for the purpose of cleaning and repairing. This operation can be done in day-light under conditions of perfect accessibility. After removal of the sections the interior of the furnace is easily accessible for inspection and repair.

If steam pressures of 600 lb. are employed the water in the boiler is approximately 100 deg. hotter than it is if the boiler carries only 200 lb. pressure. Other conditions being equal this will cause the flue gases to leave the heating surface of the boiler at a temperature of approximately 100 deg. higher than what is the usual practice. To offset the consequent loss in efficiency, without a large increase of heating surface, it is necessary to install a certain amount of economizer surface. The amount of economizer surface sufficient to offset this loss in efficiency is easily provided in the tubes which connect the feed drums to each individual section. These tubes of the boiler structure form a natural part of the boiler construction.

Under pressures as high as 600 lb. per sq. in., difficulties are encountered with glass water level indicators. A new construction of steel water level indicator is shown. The changes in the water, in this apparatus, influences the temperature of a mass of mercury, the expansion of which indicates the change.

In conclusion, it is pointed out that in judging any attempt to realize the advantages of high steam pressure it becomes necessary to balance the gain in fuel consumption against any increase in cost of the necessary apparatus. It is claimed that the boiler construction as shown, even under pressures

as high as 700 lb. per sq. in., does not involve a cost higher than that of present types of boilers for pressures not higher than 200 lb. per sq. in. It is therefore expected that the full theoretical benefit of high steam pressures can be realized in practice.

LOS ANGELES, NOVEMBER 13.

The Los Angeles Section of The American Society of Mechanical Engineers held a very successful meeting on November 13. During the afternoon and evening the members and their guests visited the laboratory of the Mt. Wilson Solar Observatory and inspected the new 100 in. mirror for the reflecting telescope now being erected on Mt. Wilson, as well as the grating ruling machine, and the mechanical and physical equipment of the laboratory. Dr. Hale spoke briefly in regard to the purpose and aims of the Observatory illustrating his talk with actual photographs and slides.

Dinner was served at the Hotel Maryland, forty-three members and invited guests being present. After the dinner, F. G. Pease, Mem. Am. Soc. M. E. and of the Observatory staff gave a talk that was profusely illustrated with lantern slides illustrating the mechanical equipment of the laboratory and its work. The laboratory and the observatory equipment are unique in that they are designed and built in the observatory shops, the equipment being designed from the standpoint of the mechanical engineer rather than the standpoint of the instrument maker.

BUFFALO, NOVEMBER 17

The Engineering Society of Buffalo held a successful meeting on November 17 at the J. P. Devine Company's plant in Buffalo, at which John Calder, President of the Metals Coating Company of America, addressed the Society on the Schoop Process of Spraying Metals. The lecture was accompanied by a very interesting demonstration of a process new to America, the coating of wood, paper, iron, steel and other substances with metals.

The importance of the process which was brought to this country by Mr. Calder from Switzerland, is, as regards steel-and-iron construction, the arrest of corrosion and rust. Mr. Calder explained that that tuberculosis which iron and steel suffers from, has been arrested to some extent temporarily by paints, enamels and their substitutes.

It is important in the preparation of food products that the vessels used do not corrode. It is important also in construction that the irons and steels do not rust; that the other metals used resist decay. Each material can be coated, to any practicable thickness desired, with electro-positive, non-corroding metals.

Bronze wires, brass wires, aluminum, lead and copper wires were melted a tiny drop at a time during the demonstration. These drops of melted metal were thrust through a spraying brush with oxygen at the rate of 3,500 ft. a second. The metal thus treated is, theoretically, blown into its component molecules. These are thrust into the fiber, grain or texture of the object and, as the spraying continues, a hard surface or coat of the metal is deposited. The coated surface may be polished if desired.

The coating process had developed a new business in novelties. Various articles, apparently metal, are now being marketed at low prices which, the lecturer explained, are really wood coated with bronze or other metals. For the engineers the chief interest was, of course, the demonstration of the claimed effective prevention of decay, which threatens all structural metals. The paper called forth considerable discussion regarding the possibilities of this process. Nearly 250 members were present.

NEW HAVEN, NOVEMBER 17

The splendidly managed fall meeting of the New Haven section was held in the Mason Laboratory of Sheffield Scientific School on Wednesday, November 17. Afternoon and evening sessions were held and about one hundred and fifty were in attendance.

Dr. L. P. Breckenridge, Mem. Am. Soc. M. E., presided in the afternoon while Charles L. Warner, Mem. Am. Soc. M. E. presented a paper on the ingenious wire-forming machines made by the Baird Machine Company, of which he is president. Albert A. Dowd, consulting engineer of New York City and on the staff of Machinery, gave most valuable information and shop hints on work-holding devices for lathes, boring mills and planers.

It is papers like the latter which return to the member of the Society many times the amount of a member's dues. The other papers were highly interesting and instructive and presented by authorities in their respective specialties, but Mr. Dowd was able to give suggestions which would save shops hundreds of dollars.

At the completion of the afternoon session, a dinner was served in the inspiring Yale Dining Club Hall.

Prof. J. W. Roe, Mem. Am. Soc. M. E., presided in the evening, when Calvin W. Rice, Secretary Am. Soc. M. E., spoke for a few moments. He stated that it would be taken for granted that the Society was especially successful so he wanted to emphasize the success of all the societies and the profession generally. Coöperation of the societies in the International and Panama Congresses, in legislative matters, with the United States in the Naval Advisory Board and in the as yet unannounced work with the War Department, indicated the more leading part the engineers are taking in society generally. Coöperation between the engineering societies in local affairs was urged and a joint meeting for the 1916 spring meeting in New Haven suggested.

Ralph E. Flanders, Mem. Am. Soc. M. E., followed with a splendid presentation of the subject of gear cutting machinery. Geo. O. Gridley, Mem. Am. Soc. M. E., who has contributed perhaps more than anyone to the advancement of the art of automatic screw machines, closed the session.

MINNESOTA, NOVEMBER 18

The November meeting of the Minnesota Section of the Am. Soc. M. E. was held at the University of Minnesota on November 18. At the afternoon session three papers were read, one by Ray Mayhew, Mem. Am. Soc. M. E., and Mechanical Engineer of the Minneapolis Steel & Machinery Company, on Stationary Gas Engines, one by S. C. Shipley, Mem. Am. Soc. M. E., and Assistant Professor of Machine Construction of the University of Minnesota, on Gas Engine Ignition, and one by W. G. Clark, Engineer for the Wilcox-Bennett Carburetor Company of Minneapolis, on Carburetion in Gas Tractor Work. Following this a dinner was served in the Minnesota Union.

At the evening session two papers were presented, one by E. Russell Greer, Mechanical Engineer for the Lion Tractor Company, on Gas Tractor Engines, and one by S. L. Hoyt, Assistant Professor of Metallography at the University of

Minnesota, on the Use of Special Steel in Gas Tractors and Automobile Construction. There was a total attendance of 145 members, visitors and students.

PROVIDENCE-BOSTON, NOVEMBER 18

A very successful joint meeting of the Providence Association of Mechanical Engineers and the Boston Section of the Am. Soc. M. E. was held in Providence on November 18. In the afternoon a choice of excursions was given to the Gorham Manufacturing Company, the largest firm of silversmiths in America; the General Fire Extinguisher Company, the largest fire prevention company in the world, and the Brown & Sharpe Manufacturing Company, so well known for the high grade tools and machines manufactured. The last part of the afternoon the members and guests were cordially received and entertained by the Brown University authorities in the engineering laboratories. Following this, a banquet was served at 6:15 at the Hotel Narragansett. The meeting was presided over by A. H. Annan of the Providence Association, and he introduced William Howard Paine as toastmaster. The visiting members to the city were cordially welcomed by His Honor Mayor Joseph H. Gainer. Following this, Dr. W. H. P. Faunce, President of Brown University, spoke of the engineers, not as malefactors but as factors of great wealth, and said that to judge by the attendance of over 500, engineering appears to be as popular as politics. He mentioned the need of applied science and the necessity of harnessing thinking with practical work to bring results and value to the world at large.

Prof. Charles E. Munroe, Dean of George Washington University, gave a very interesting and instructive discussion of the subject of Explosives and the Engineer, pointing out the various characteristics in different kinds of explosives, giving their history and important results achieved. To illustrate the enormous amount of explosives used he mentioned that nearly 9,000,000 lb. per year had been used at Panama, and that on October 10, 1885, Hell Gate was blown up by a charge of 285,000 lb. of dynamite and rackarock, this being the largest charge ever set off at once, and blowing up an area extending over nine acres.

Morris L. Cooke, Director of Public Works at Philadelphia, spoke of his experiences as an engineer in public office. He stated that public business should be modeled on private business, that city governments as a rule have little control over, or knowledge of public service corporations, and that the greatest accomplishment of a municipal engineer or contractor of public works can be in connection with public utilities. He stated that people did not object to authorizing the expenditure of money, provided they got objective evidence that they were to receive one dollar's value for one dollar expended.

Next followed an exposition of the development of an international telephone system by M. C. Rorty, Engineer of the American Telephone and Telegraph Company, illustrated by moving pictures, and later by actual conversation with San Francisco, each one present being provided with an individual receiver. This feature was carried out through the courtesy of the management of the American Telephone and Telegraph Company.

The joint meeting was a very successful one and there were nearly 600 members present at the banquet. The papers which were presented appear in the technical section of this issue of The Journal.

PHILADELPHIA, NOVEMBER 23.

A meeting of the Philadelphia local section was held on November 23, 1915, at which W. P. Barba of the Midvale Steel Company presented a paper on Industrial Safety and Principles of Management. This paper is printed in full in another part of this issue.

NECROLOGY

ROBERT A. MCKEE

Robert A. McKee was born on September 12, 1873, in Towanda, Pa. He graduated from Lehigh University with the degree of M. E., in 1895. For a short time after graduation he was employed by the Brooks Locomotive Works of Dunkirk, N. Y., as draughtsman and designer. He then went to Cornell University to take a course in Marine Engineering, receiving in 1897 the degree of M. M. E. Returning to the Brooks Locomotive Works, he worked in the capacity of designer. In 1899 he became connected with the Baldwin Locomotive Works, remaining there until 1900, when he took a position with the Holly Manufacturing Company of Lockport, N. Y. Here he started as a tracer and was rapidly advanced to the position of leading designer. After fifteen months he left this position to enter the employ of the Westinghouse Machine Company at East Pittsburgh, Pa. In 1904 he was engaged by the Allis-Chalmers Company to take charge of the development and construction of steam turbines. It was due to his efforts more than those of any other individual that the steam turbine department developed along lines which have proved to be based on correct fundamentals. His advice on steam problems was sought by leading engineers and his reputation as a steam turbine engineer extended to foreign countries. Mr. McKee was a member of the American Institute of Electrical Engineers. He died in New York on September 5, 1915.

RAYMOND EARL CRANSTON

Raymond Earl Cranston was born in Providence, R. I., on November 25, 1883. He was educated in the Providence schools, spent one year in Brown University, and graduated with honor in 1906 from Massachusetts Institute of Technology with the degree of B. S. He then entered the employ of the Manufacturers' Mutual Fire Insurance Company of Boston. Later he was sent to the Providence office and became associated with John R. Freeman in his private engineering work. In 1912 he went to California with Mr. Freeman as assistant on the Hetch-Hetchy water supply for San Francisco. Soon after he became assistant engineer for the insurance company.

Mr. Cranston was a member of the Providence Society of Mechanical Engineers. He died at his home in Providence on June 25, 1915.

JOHN LOYD

John Loyd was born in Newton, Mass., on May 1, 1837. He received his education in the public schools, and learned the machinist and engineering trades. At the outbreak of the Civil War he entered the United States Navy. He was commissioned as acting third assistant engineer and was later promoted to first assistant engineer. On May 7, 1867, he was ordered to the Portsmouth Navy Yard as assistant engineer, and was granted an honorable discharge Decem-

ber 27 of the same year. Shortly afterward he started into business in New York City in the manufacture of machinery, knives and dies under the firm of McLoughlin, Grover and Loyd. On the death of his partners he continued the business under the name of the John Loyd Company.

Mr. Loyd was a member of the Military Order of the Loyal Legion, the Navy League, the Society of Naval Architects and Marine Engineers, the American Society of Naval Engineers and the Metropolitan Museum of Art. He died at his home in Brooklyn on October 5, 1915.

HORACE WYMAN

Horace Wyman, whose death occurred on May 8, at his country home in Princeton, was born in Woburn, Mass., on November 27, 1827. He was educated in the academies at Woburn and Francestown, N. H., and began his business career in 1846, when he became a machinist in the works of the Amoskeag Manufacturing Company at Manchester, N. H. He was later employed by the Lowell Machine Company and by the Hinckley Locomotive Works at Boston, and served as draughtsman with the Holyoke Water Power Company.

About 1860 Mr. Wyman became associated with George Crompton of Worcester. He was made superintendent and manager of the Crompton Loom Works, holding that position until the consolidation of the business under its present name of Crompton & Knowles Loom Works. Mr. Wyman was then made vice-president and consulting mechanical engineer of the company, retaining that position until his death.

All through his many years of service with the Crompton and the Crompton & Knowles Loom Works he applied himself to invention of looms and textile machinery until he had practically perfected looms as they are now used. His inventions made it possible for woolen, gingham and silk fabrics to be woven in more than one color and in larger pieces than before. Through the processes developed by him, rugs and carpets can now be manufactured in size large enough to cover the floor of a room. Textile mills all over the country are using every day machines invented by Mr. Wyman. He is regarded as having done more for the loom industry than any other man in Worcester and possibly in the country. His inventions were the largest single factor in the success of the Crompton & Knowles Loom Works.

He was a member of the Worcester County Mechanics' Association and the Worcester Society of Antiquity.

WILLIAM WATSON

William Watson was born in Nantucket, Mass., on January 19, 1834, and died at his home in Boston on September 30, 1915. He graduated from Harvard in 1857, and took the Boyden prize for mathematics in which he excelled in his work in engineering. The same year he became an instructor at Harvard in differential and integral calculus. Later he took a course of special study at the École Nationale des Ponts et Chaussées in Paris. On returning to this country he became university lecturer at Harvard. While in Europe, Prof. Watson collected from 1860 to 1863 information on technical education which was made the basis of a plan of organization in 1864 of the Massachusetts Institute of Technology, where from 1865 until 1873 he was professor of mechanical engineering and descriptive geometry.

Professor Watson was United States Commissioner in 1873 to the Vienna Exposition and he served as a member of the International Jury of the Paris Exposition in 1878. He had been honorary president of the Paris Congress of Architects and vice-president of the engineering section of the French Association for the Advancement of Science, serving several terms, and vice-president of the International Congress of Construction in 1889.

He was a member of the French National Academy at Cherbourg, Société des Ingénieurs Civils de France and the American Society of Civil Engineers. He was a fellow of the American Academy of Arts and Sciences, member of the American Association for the Advancement of Science, the Colonial Society of Massachusetts and the Mathematical Club. He was the author of many notable works on technical education and science, engineering, architecture and other subjects.

WALTER SEAVER BALL

Walter Seaver Ball was born March 17, 1867, at Upton, Mass. He was educated in the Upton schools and graduated from Worcester Polytechnic Institute with the degree of S. B. in 1889. He was associated for a short time with the Dean Steam Pump Company at Holyoke, and in 1894 he became connected with the McKay Metallic Fastening Association as assistant to the superintendent. He then became assistant superintendent with the United Shoe Machinery Company and later moved from Winchester to Beverly with this company. For twenty-three years Mr. Ball held a position of great responsibility with the allied companies making this great industry. He died on September 11, at the Beverly Hospital.

TEILE HENRY MÜLLER

Teile Henry Müller was born January 18, 1841, at Grossensiel-Oldenburg, Germany, and was educated at the Polytechnic School of Hannover, completing the course in mechanical engineering in 1862. He then entered the service of the North German Lloyd Steamship Line as ship engineer. In 1865 he came to New York and was engaged first as machinist and later as draughtsman by the Root Steam Engine Company. He left this firm in 1866 to accept a position as superintendent engineer with the Convex Weaving Company, designing and building their mill and machinery. He then took the position of superintendent with the Eagle Pencil Company to redesign their machinery and revise the processes of manufacturing pens, pencils and other articles. In 1877 he entered the employment of S. S. Hepworth & Company, sugar engineers, as superintendent. He designed the California Sugar Refinery in San Francisco for Claus Spreckels and the Belchers Refinery in St. Louis, and built a large part of the machinery for these factories. Later he designed and built the Spreckels Refinery in Philadelphia, the National Sugar Refinery in Yonkers, and designed and partly built the Camden Sugar Refinery. In 1900 he was engaged by the Federal Sugar Refining Company as constructing engineer and built their works in Yonkers in 1914. Mr. Müller continued in this position until the time of his death, which occurred on September 21, 1915.

WALTER K. MITCHELL

Walter K. Mitchell was born October 13, 1866, in Glasgow, Scotland, and came to this country very early in life. He was educated in the schools of Pittsburgh and served an apprenticeship as machinist with the Jones & Laughlin Steel Company. From 1889 to 1899 he was employed as sales engineer by Best Fox & Company of Pittsburgh, piping

engineers and contractors, going to Philadelphia as their eastern representative in 1893. In 1899 he formed the partnership of W. K. Mitchell & Company, specializing in high pressure piping and its accessories. When this partnership was changed to a corporation in March 1909, Mr. Mitchell was elected president and treasurer. He continued actively in these offices up to the day of his death, which occurred on November 6, 1915.

AUGUSTUS JAY DU BOIS

Augustus Jay DuBois was born April 25, 1849. He was graduated from the Sheffield Scientific School in 1869, and was awarded the degree of civil engineer in 1870 and the degree of doctor of philosophy in 1873. Later he studied mechanics for two years at the Mining Academy in Freiburg, Saxony, and from 1875 to 1877 he was Professor of Civil Engineering and Mechanical Engineering at Lehigh University. In 1877 Professor DuBois was appointed Professor of Mechanical Engineering in the Sheffield Scientific School and in 1884 was transferred to the Professorship of Civil Engineering which position he occupied until his death.

Professor DuBois was the author of some of the best-known treatises on mechanics and stresses in the English language. His book on Graphic Statics, published in 1876, was largely instrumental in introducing to American engineers the graphic method of determining stresses in framed structures now so widely used. This was followed by his translations of Röntgen's Thermo-dynamics, Weyrauch's The Calculation of the Strength and Dimensions of Iron and Steel Construction, and Hydraulics and Hydraulic Motors and Heat, Steam and the Steam Engine from Röntgen's Mechanics. In 1883, his elaborate and original book on Strains in Framed Structures took its place as one of the most important contributions to engineering literature, being perhaps the first comprehensive treatment of the subject. A series of books on mechanics culminated in his Mechanics of Engineering published in 1901.

Professor DuBois was a member of the American Society of Civil Engineers, the American Institute of Mining Engineers, the Connecticut Society of Civil Engineers and the Society for the Promotion of Engineering Education. He died on October 19, 1915.

DWIGHT E. LYMAN

Dwight E. Lyman was born in Marshall, Oneida County, N. Y., on October 12, 1845. He was educated in the Deansville schools, and served an apprenticeship at the Willowvale Machine Works of Utica. Later he was employed for four years as superintendent and draughtsman by Keeney Bros. of Manchester, Conn. At the age of 20, he went to Hartford, and soon entered the employ of Asa S. Cook, serving as superintendent and mechanical engineer from 1875 to 1882. After this for one year he held a similar position with the Syracuse Screw Company, returning in 1833 to the Asa S. Cook Company as superintendent, the position he held at the time of his death. Mr. Lyman died at his home in Hartford on July 8, 1915.

JOHN E. WARREN

John E. Warren was born in Grafton, Mass., on October 7, 1840; but when he was still an infant his parents travelled West as pioneers and settled on a farm in Wisconsin, where the boy grew up. The short term country schools of the day supplied all there were of his opportunities for schooling, except that he supplemented them afterward for a time by teaching, and then by entering Ripen Academy shortly before the outbreak of the Civil War. He promptly enlisted in the Union Artillery, and served with it through to the end.

Not long afterward he entered the employ of S. D. Warren & Co., makers of book paper. It was to this company at its plant at Cumberland Mills, Maine, that Mr. Warren devoted his business and professional service to the close of his life. He began as a mechanic, worked upward through various capacities, until in 1883 he was appointed Agent of the Mills, thus becoming the head and leader of its organization, the position which he retained for thirty-two years, up to his death. His interest turned naturally to engineering. The expansion of the mills, their growth which multiplied their capacity and value over four times during his administration of them, brought out the need for engineering services of high order.

Mr. Warren had been a member of the Society since 1886. He died on August 13, 1915.

PERSONALS

Gustave Eiffel, Hon. Mem. Am. Soc. M. E., has been appointed by the French Minister of War on the Consulting Committee of Experts on Military Aeronautics.

Charles E. Burgoon has resigned from the position of inspector of mechanical and electrical engineering with the Panama Canal, Washington, D. C., and has been appointed chief mechanical and electrical engineer with the Carbolite Chemical Company (Tennessee Copper Company), Copperhill, Tenn.

Thomas C. Shedd has resigned his position as instructor in mechanical engineering at Brown University, Providence, R. I., and has accepted a position with the Phoenix Bridge Company, Phoenixville, Pa., as draftsman.

Forrest W. Manker has become associated with the Moulton Engineering Corporation, Portland, Me. He was until recently connected with the B. F. Sturtevant Company as manager of their Hartford, Conn., office.

Cleon E. Phelps, formerly affiliated with the physical laboratory of the American Steel and Wire Company, Worcester, Mass., as mechanical engineer, has accepted a similar position with the American Optical Company, Southbridge, Mass.

Fred J. Bechert has resigned his position as instructor of mechanical engineering in the Texas Agricultural and Mechanical College, College Station, Texas, and has accepted the position of assistant examiner in the United States Patent Office, Washington, D. C.

The Lavigne Gear Company, Racine, Wis., one of the most extensive manufacturers of steering gears for pleasure and commercial vehicles in the United States, has been reorganized, its corporate name being changed to Lavine Gear Company. Mr. Herman A. Uihlein is president and treasurer of the company.

B. A. Behrend is the author of a brief article on Balanced Engineering which appears in the November issue of the Electric Journal.

John C. Parker has resigned as head of the engineering department of the Rochester Railway and Light Company, Rochester, N. Y., to accept the chair of electrical engineering at the University of Michigan, Ann Arbor, Mich.

Some Facts about Insulation by Henry A. Cozzens, Jr., is published in the November number of Electrical Age.

P. D. Wagoner was elected one of the directors of the Electric Vehicle Association of America at the October 18 and 19 convention in Cleveland.

Dr. Charles P. Steinmetz was elected, on November 2, president of the Common Council of the city of Schenectady, N. Y., on the ticket of the local socialistic party.

One of the many papers presented at the 23d annual meeting of the Naval Architects and Marine Engineers, November 18 and 19, in New York, was Some Comparisons Relating to Electric Propulsion of a Battleship by W. L. R. Emmet.

George K. Miltenberger, who has been stationed at Hickman, Ky., for several months in the capacity of local manager of the Public Service Company, which operates the city light and water plants, has been transferred to St. Louis.

A. J. Purinton, who was formerly manager of the East St. Louis, Ill., Light and Power Company, has accepted a position as general superintendent of the Atlantic City and Shore Railroad Company at Atlantic City, N. J.

Harold Carpenter, resident engineer of the Astoria Tunnel, Astoria Light, Heat and Power Company, New York, has contributed an article on Flooding and Recovery of the Astoria Tunnel to the November 1 issue of The Gas Age.

The Chamber of Commerce of Worcester, Mass., announces that an International Road Congress will be held in that city December 14 to 17, inclusive. The Massachusetts Highway Association and the Federal Government will coöperate with the local authorities in conducting the meeting. Among the engineers on the program for the Congress are Clifford Richardson, W. W. Crosby and Ira N. Hollis.

Nathan C. Johnson is a member of the advisory committee appointed by the United States Bureau of Standards to report upon the advantages of the use of hydrated lime in concrete.

Walter N. Polakov has resigned as superintendent of power of the New York, New Haven and Hartford Railroad, to engage in consulting practice. In the 18 months he had charge of the operation of the power plants of the New Haven, he effected a saving of 25 per cent in the cost of electric power.

Paul M. Lincoln has resigned from his position in the engineering department of the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., to devote his time to the manufacture of a meter which he has recently developed.

A. C. Dinkey, formerly president of the Carnegie Steel Company, Pittsburgh, Pa., now president of the Midvale Steel Company, Philadelphia, was tendered a farewell banquet by 60 operating officials of the Carnegie Company, October 30, at the Duquesne Club, Pittsburgh. Judge J. H. Reed presided.

Among those presenting addresses at the 19th annual convention of the National Founders' Association which was held at the Hotel Astor, New York, November 17 and 18, were M. W. Alexander and Albert G. Duncan.

Henry D. Sharpe, treasurer of the Brown and Sharpe Manufacturing Company, Providence, R. I., has given $1000 toward a fund for a new home for the Providence Boys' Club, and also $100 to the military aeroplane fund of Rhode Island.

Dr. John A. Brashear, President Am. Soc. M. E., has been appointed a delegate to the Pan-American Scientific Congress, which will meet in Washington, D. C., December 27 to January 7.

F. C. Trowbridge has been elected president of the Manufacturers' Association of Hamilton, O., which has recently been organized. The object of the association is to bring about closer coöperation between employers and their employees and later on it is proposed to take up the matter of industrial education.

Frank A. Burr, formerly associated with the Spray Engineering Company, Boston, Mass., has been appointed instructor in power plant design at Pennsylvania State College.

Among those who took part in the addresses and discussions given at the conference on valuation held in Philadelphia, November 10 to 12, were: Morris Knowles, H. P. Gillette, Morris L. Cooke, Manager Am. Soc. M. E., John R. Freeman, Past President, Am. Soc. M. E., and Leonard Metcalf.

The November issue of Machinery which is largely devoted to safety and welfare work in manufacturing plants and selling organizations, contains a contribution by Forrest E. Cardullo on A Study of Safety and Welfare Work in Manufacturing and Selling Organizations. This article covers comprehensively safety and sanitation, housing of employes, coöperative organizations, profit-sharing systems, pensions, workmen's compensation, etc. Another article on this subject, entitled Safety Organizations of a Machine Shop, has been contributed by Luther D. Burlingame.

Frank O. Hoagland, works manager of the Union Metallic Cartridge Company, Bridgeport, Conn., has resigned the position to become assistant to B. M. W. Hanson, vice-president and works manager of the Pratt and Whitney Company, Hartford, Conn.

W. H. Winterrowd is the author of an article on First 4-8-2 Locomotives in Canada which appears in the November issue of the Mechanical Edition of the Railway Age Gazette.

A. L. Graburn, mechanical engineer of the Canadian Northern at Toronto, Ont., Canada, has been appointed assistant superintendent of rolling stock of the Eastern lines, with office at Toronto.

A. E. Ostrander has been appointed mechanical engineer of the American Car and Foundry Company, New York, succeeding John McE. Ames who recently resigned. Mr. Ostrander entered the service of the American Car and Foundry Company in 1903 and has been with the company continuously since that time.

Alan A. Wood, previously at the Providence, R. I., office of the Builders Iron Foundry as sales engineer in the venturi meter department, has become associated with their Pacific Coast agents, Norman B. Livermore of San Francisco and Los Angeles, in an engineering and sales capacity.

George H. Thorpe, until recently connected with the Millville Manufacturing Company, Millville, N. J., has accepted a position with John A. Stevens of Lowell, Mass., in the capacity of mechanical engineer.

H. O. Hem, formerly vice-president and superintendent of the H. N. Strait Manufacturing Company, Kansas City, Mo., has become a member of the engineering staff of the Toledo Scale Company, Toledo, O., in the capacity of consulting engineer.

Frank E. Watkins has become connected with the East Jersey Pipe Corporation, Paterson, N. J., as works manager. He was formerly associated with the Canadian Fairbanks-Morse Co., Ltd. of Toronto, Ontario, Canada.

Williams Alston Stevenson, former member of the Society and brother of A. A. Stevenson died on October 22. He was a graduate of Lehigh University of the class of 1890. Shortly after graduation he was made superintendent of the Stearne Manufacturing Company at Erie, Pa., and later superintendent of the Akron Plant of the Wellman-Seaver-Morgan Company. For a number of years previous to his death he was general manager of the Keystone Drop Forge Works at Chester, Pa.

J. Harland Billings has become associated with Johns Hopkins University as instructor in mechanical engineering.

STUDENT BRANCHES

ARMOUR INSTITUTE OF TECHNOLOGY

The opening meeting of the Armour Institute of Technology Student Branch was held on October 21. The meeting was in the form of a smoker to which the Junior students in mechanical engineering were invited. J. M. Byanskas, president of the Branch, opened the meeting and outlined the policy for the coming year. Professor Gebhardt further discussed the plan which is to have more open discussion of important topics in which everyone takes part rather than have outside speakers.

CARNEGIE INSTITUTE OF TECHNOLOGY

The Student Branch of the Carnegie Institute of Technology held its first meeting of the school year on October 13. A. V. McNamara, president of the Machinists Union, spoke on the Relation that should exist between the Engineer and the Workmen in the Shop. He explained fully his position as leader of the movement that is making such a strenuous campaign to procure better wages, working hours and working conditions for the workmen. He declared himself to be strongly in favor of woman suffrage and expressed his opinion that that movement would be a great effect in producing a more desirable situation for workmen.

He then made an analysis of the relation between the workmen and the engineer. He showed how deplorable it is that many concerns maintain such a wide gap between the engineering department and the shops. In this connection, he pointed out with examples how the workman discovers and rectifies points that the engineer has not recognized, and which the workman cannot bring to the engineer's attention. Mr. McNamara called attention to the fact that all labor laws and improvements were brought about through the efforts of organized labor and that the engineers benefited just as much by them as those who had brought them about.

Following the address, there was an extended discussion upon open shops, the violation of labor laws by manufacturers, the bad effect of liquor and future prospects. Mr. McNamara expects that the next big movement in labor organization will be the consolidation of all of the unions.

CASE SCHOOL OF APPLIED SCIENCE

The first regular meeting of the Case School of Applied Science Student Branch was held on November 3. An illustrated address on The Electrification of Steam Roads Within the City Limits of Cleveland was given by E. P. Roberts, City Smoke Inspector. Mr. Roberts showed the importance of the problem of the electrification of the steam roads entering the city, since the citizens as well as the railroads are benefited by the increased prosperity of the city. He urged that no construction work should be allowed that would interfere with electrification whenever it should come. The advantages to the city that would come as a result of this step would be: first, the elimination of smoke and cinders; second, the increased traffic facilities; third, the possible suburban traffic and the improvement of the interurban. The areas affected by the smoke and cinders of the steam roads now in use represent 65 per cent of the entire city area, the affected zones being taken a thousand feet on either side of the track. Of this the cinder area is one fifth or 13 per cent of the city area. The greater part of the smoke is from switching engines which are used every day at the rate of 122 per hour, against 24 freight and 12 passenger locomotives per hour. The only method of smoke abatement possible with present systems is a change in equipment, which would be almost as expensive as electrification. In comparing the smoke emitted by locomotives and that from other sources, it was stated that black smoke is emitted much oftener and in larger quantities by the locomotives because of their construction, and the damage and annoyance due to smoke from locomotives is greater, since there is no high stack to carry up the smoke and fumes and so spread them out over large areas. The speaker discussed also the various systems of electrification available, including both direct and alternating current types using trolley wheel, pantograph or third-rail contractors. He concluded by recommending careful and immediate consideration of this problem.

KANSAS STATE AGRICULTURAL COLLEGE

At a meeting of the Kansas State Agricultural College Student Branch held on November 4, A. Douglas was elected treasurer. Prof. G. B. McNair gave a talk on a Summer at the Westinghouse School for Teachers. J. H. Welsh read a paper on The Flour Mill at Kansas State Agricultural College. This is a model mill with all the modern equipment. Mr. Welsh told of the different processes the whole wheat must pass through before it is converted into flour, and described the arrangement of the machinery. Gabe Sellers reviewed an article on the Panama-Pacific International Exposition, which appeared in the October issue of The Journal, and J. J. Abernethy gave a talk on Clayton's Analysis, taken from a bulletin publication of the University of Illinois.

LEHIGH UNIVERSITY

The first meeting of the Lehigh University Student Branch was held on October 28 at which M. W. Kresge, '16, gave a talk on Military Engineering and L. Mardaga, '16, gave a talk on Surface Condensers. Mr. Kresge's talk dealt with his experiences with Engineer Companies at Student's Military Instruction Camps. He spoke briefly on field engineering, permanent fortifications, building of bridges and reading and drawing military maps. Mr. Mardaga spoke of condensers as connected with their use in the low pressure steam turbine. He also spoke of various apparatus used to produce the necessary vacuum and made a few remarks affecting the design of a surface condenser.

At a meeting on November 18 the best talk was by Prof. T. E. Butterfield, who spoke on "Diesel Engines." Professor Butterfield gave a brief history of the early development of these engines and also a general talk on the modern Diesel Engines illustrated by lantern slides.

The second speaker was J. M. Wells, '16, who described the trip of the Senior Mechanicals to the L. C. & N. Co.'s power plant at Haute on November 3.

J. M. Bausman, '16, spoke on "Schrapnel." He described manufacture of cases, schrapnel, and fuse, giving methods of pressing out cases and steel casings and finishing them. He also spoke on the contents of the steel casing and the workings and object of the fuse.

LELAND STANFORD, JR. UNIVERSITY

A business meeting of the Leland Stanford, Jr. University Student Branch was held on October 13, 1915. A large part of the meeting was devoted to a discussion of an amendment to the constitution whereby the dues of regular members shall be fixed at $4.00 per year with an additional initiation fee of $1.00 for new members. This will include a subscription to The Journal. This amendment will be put to a vote at the next meeting of the Branch.

At this meeting, J. L. Reynolds gave a very interesting talk on a plant for the extraction of gasoline from the "wet" natural gas which comes from wells producing oil with a parafine base.

On October 27, thirty-six new members and Department members of the faculty were entertained at a smoker given at El Campo. Prof. W. F. Durand spoke on the advantages derived from the formation and work of Engineering Societies and Associations and the value of being connected or affiliated in some way with one of them.

Prof. G. H. Marx spoke on the initiative of the western student, and made a brief forecast of engineering activities for the next few years.

OHIO STATE UNIVERSITY

The Student Branch of the Ohio State University of American Society of Mechanical Engineers held a regular meeting on November 12 and were entertained at the home of Prof. and Mrs. Wm. F. Magruder.

Officers for the present semester were elected, and the programme for the year was discussed. It was decided to fea-

ture the meetings with talks from prominent engineers in the City of Columbus, and by papers written by members of the society.

The officers elected were as follows: Harold H. Brooks, president; Hugh V. Walborn, vice-president; Ray Ellis, secretary; Maurice A. Nettleton, treasurer; Alex. F. Landefeld, sergeant-at-arms.

PENNSYLVANNIA STATE COLLEGE

The regular monthly meeting of the Pennsylvania State College Student Branch was held on October 28. An illustrated lecture on the Panama Canal was given by H. P. Vail, who was employed in engineering work there during the past summer. Mr. Vail discussed the methods used in the construction of the canal and told of its operation as a waterway and of the improvements in sanitation which this Government has brought about. He also described the operation of the locks, explaining how the lock engineer, at a switchboard with a miniature layout of the system, has full control of a whole system of locks.

PURDUE UNIVERSITY

The first meeting of the Purdue University Student Branch, held on September 28, was a general get-together meeting, at which refreshments were served and talks were given by some of the professors.

At a meeting on October 12, William Borgard spoke on Electric Starting, Lighting and Ignition Systems and Their Failings.

At the third meeting of this Branch on October 26, an interesting talk was given by J. H. Emrik of the Senior Class on Automatic Adding Machines of the National Cash Register Company and also on the Company's Products, Organization and Welfare Work.

The idea for the cash register came to the originator on an ocean liner where he saw a revolution counter in use. The first register built counted only to a dollar, but great and rapid advancements have been made until now, it is a necessity in stores, both as a protection and an aid to the store manager against employees. Those of the latest design even furnish the customer with a receipt.

It is very essential that the cash register be designed and made very accurately and carefully. Often careless and inexperienced clerks operate the machines and certain parts have to be made heavier to withstand abuse. Above all, the machine must add correctly.

For the purpose of giving information, separate counters, separate transaction counters, customer counters, total counters and a variety of others are provided.

When Mr. Emrick had finished his talk on the cash registers, he was asked to tell about the welfare work which the Cash Register Company is doing for its employees. Apprentice courses are provided in every profession and trade found in the plant, and both day and evening classes of every kind are held. The lecture course is of a very high type and very often motion pictures illustrating the making of several kinds of manufactured products from rough material to the finished products are used in connection with the lecture. A library is also provided at a nominal cost to the readers. Athletic sports of all kinds are provided, including a country club for golf, and there is a well organized medical department, which is at the disposal of the employees for a small fee.

STATE UNIVERSITY OF KENTUCKY

At a meeting on September 24, the State University of Kentucky Student Branch was organized and the following officers were elected: Prof. F. P. Anderson, honorary chairman; J. D. Garrett, chairman; H. Worsham, vice-chairman; G. L. Cherry, secretary and treasurer. The chairman appointed T. C. Taylor chairman of the porgram committee, to be assisted by H. Worsham and H. E. Melton. The governing committee, composed of the officers and Professor Anderson as ex-officio member, was appointed.

At a meeting of the branch on October 29, N. C. Johnson's paper on the Hydration of Portland Cement, which appeared in the September issue of The Journal, was discussed and illustrated by means of a projectoscope. The other articles discussed were The Connors Creek Plant of the Detroit Edison Company and Graphical Tables for Calculating Reciprocating Compressors.

UNIVERSITY OF CALIFORNIA

At a meeting of the University of California Student Branch on October 26, a paper on Electric Arc and Percussive Welding was read by E. Eichler.

The following officers were elected at a meeting of the branch held August 31: C. Sebastian, chairman; M. Jones, vice-chairman; E. Eichler, secretary; H. Crow, treasurer.

UNIVERSITY OF CINCINNATI

Afternoon meetings of the University of Cincinnati Student Branch of the American Society of Mechanical Engineers were held October 7 and 28 for the purpose of explaining to the underclassmen, in Sections I and II, what the American Society of Mechanical Engineers is, its mission and work in the University. Talks were given by Prof. J. T. Faig, Prof. A. L. Jenkins, and C. Joerger. At the close of the meetings opportunity was given to the visitors to become members and forty men signed up.

On the afternoon of October 21 an open meeting was held, at which G. A. Monnett, formerly Chief Smoke Inspector of Chicago and Associate Editor of Power, was the speaker. His main topic was boilers, boiler settings and draft. A great many slides of different makes of boilers in their settings were shown, accompanied by tables showing the draft at different points in the setting. An interesting history of the development of the Chicago Standard Setting was given.

The first evening session and smoker was held October 29 at which Mr. Mittendorf, Assistant Chief Engineer of the Cincinnati Traction Co., spoke on tests of different coals, carried on by him, in order to determine the most economical coal for use in their power plants. The tests were run in their own plants, under ordinary working conditions, with the same draft, and with average firemen. The coal in Cincinnati comes from five or six different states, and the coal from each field is different from that of every other.

In order to show high over-all economy for a company, the coal must not be too expensive, must be adaptable to the present furnaces of the company, must show a high number of lb. of water evaporated per lb. of coal, must not be too high in ash, be free from clinker, and comparatively near for low freight rates.

A chart was shown, giving the results of these tests on the different kinds of coal. The advantages and disadvantages of the different coals were clearly shown.

UNIVERSITY OF COLORADO

At a meeting of the University of Colorado Student Branch on October 28, F. G. Gardner of the Department of Safety of the Interstate Commerce Commission read a paper on Mechanical Engineering on the Commission. This paper was the first of a series to be given by Mr. Gardner before the branch on the mechanical engineering side of the work of the commission. He discussed especially the legislation providing for safety devices and their development on railway rolling stock for the safety of the employees.

UNIVERSITY OF MAINE

The first regular meeting of the Student Branch of the University of Maine was held on September 28 at which the following officers were elected: J. M. Dodge, president; L. T. Rowley, vice-president; A. G. Smith, secretary and treasurer; Prof. C. H. Lekberg, honorary chairman, and L. E. Mulloney and G. C. Marble, executive committee.

UNIVERSITY OF MICHIGAN

The first regular meeting of the University of Michigan Student Branch was held on October 21, at which a special election was held. H. S. Manwaring resigned the secretaryship to become president of the branch. Frank C. Riecks

was elected vice-president and corresponding secretary; Gordon Smith, treasurer, and E. H. Merritt, recording secretary. Plans were discussed relative to the membership campaign and to holding a smoker for the purpose of stimulating interest in the branch. A motion was carried to raise the renewal rate for The Journal for graduates from $2.00 to $2.50 and to use the extra $0.50 toward the support of the branch.

UNIVERSITY OF MINNESOTA

The second regular meeting of the University of Minnesota Student Branch was held on October 16. Lieut. E. P. Rollman of Battery F, First Field Artillery, M. N. G., spoke on the manufacture and use of shrapnel. After giving briefly the history of the development of this modern shell and describing the styles used by the European nations, he explained with the aid of two section models the construction and firing mechanism of standard United States shells.

UNIVERSITY OF MISSOURI

A meeting of the University of Missouri Student Branch was held on October 21. Professor W. J. Shephard of the Political Science department of the University of Missouri spoke on City Managership, a New Field for Engineers. In his talk, Professor Shephard said that our city governments and civic affairs were coming to be run as a business proposition, instead of under the corrupt and inefficient political rule of politicians.

The city's business must be organized and managed the same as that of any business firm or corporation. The corporation, which would adopt the practice of having its officers and employees elected, as is the case in the management of most cities, would soon go into bankruptcy on account of the inefficiency resulting. The same is true of the present election system in most cities it results in inefficiency, which in some instances has become so bad as to be brought forcibly to public attention throughout the whole country. The professional element is as necessary in the management of city government as in that of a corporation.

The speaker then showed by the use of a diagram how things are run under the present elective system, and how there is a lack of the responsibility element present of the worst sort. He then explained the new commission form of government for cities, and used as examples several of the cities of this country, which have adopted it, especially Dayton, Ohio. Dayton's system consists, first, of a commission of five men, who are elected by the people. They, in turn, appoint a city manager, in whose hands rests the active management of the city's affairs. It is not necessary for him to be a resident of the city at the time of his appointment; in fact, this is hardly ever the case. In most cases he is an engineer, and has charge of the hiring of the men under him. In other words, he is to the city as the chief engineer of a manufacturing company is to his company. Wherever this system has been tried, it has brought increased efficiency over that of the old system, for the lack of the responsibility element is no longer present, and each employee must be efficient to hold his job.

The speaker then outlined what he considered the three chief characteristics of the city manager, namely: *a* He should be a good all around engineer. Under this head, he mentioned some of the duties, classified under the various branches of engineering, which would fall to the city manager, especially in the small city. Under mechanical and electrical engineering he placed supervision of power and light plants, water works, heating and ventilation for public buildings, etc. Under civil and sanitary engineering he placed care and building of roads and pavements, sewerage systems, etc. *b* He must be a good business man. *c* He must have a thorough knowledge of men, and know how to manage them successfully. He pointed out how this position for the engineer, not only was one of dignity and honor and of good compensation, but it gave him an opportunity for the accomplishment of big things, and also that the number of cities using this form of management was increasing rapidly, thus enlarging this field of engineering activity. So he urged those who were students in mechanical engineering to consider seriously the advantages and opportunities offered in this field.

The following officers were elected for the first semester 1915-16: J. C. Squires, president; Fred P. Hutchison, secretary-treasurer; Ralph Coatsworth, corresponding secretary; Professor J. R. Wharton, Troy Russel and F. Nelson Westcott, Governing Board.

UNIVERSITY OF NEBRASKA

A meeting of the University of Nebraska Student Branch was held on October 2. Practically the entire evening was devoted to a discussion of several practical problems of interest to the engineer in general. These problems were sent in by outside engineers in practical work. Professor Hoffman announced the problem by sketch and explanation. The discussion was very enthusiastically entered into.

YALE UNIVERSITY

At a meeting of the Yale University Student Branch held on October 5, the following officers were elected: E. B. Ripley, chairman; W. B. Day, secretary, and W. C. Keeley, treasurer.

EMPLOYMENT BULLETIN

The Secretary considers it a special obligation and pleasant duty to be the medium of assisting members to secure positions, and is pleased to receive requests both for positions and for men. Copy for the Bulletin must be in hand before the 18th of the month.

POSITIONS AVAILABLE

The Society acts only as a "clearing house" in these matters and is not responsible where firms do not answer. Stamps should be enclosed for forwarding applications.

69 Representatives wanted in all the leading cities for a line of vacuum heating specialties. Apply through Society.

108 Large European concern wants superintendent thoroughly posted in the manufacture of rubber shoes, technical and surgical articles, covering for rollers, tubes of all kinds, balls, toys and similar articles made of rubber.

116 Technically educated engineer wanted in the further development of plans for constructing an improved rock-tunneling machine now in operation in New York. Will require engineer having sufficient financial backing to be able to devote part time to this proposition until placed upon self-sustaining basis and before any considerable return can be expected.

136 High grade designers wanted by Pennsylvania concern. Men needed with drawing office experience, particularly on heavy machine tools and similar machinery.

140 Engineer, or designer and draftsman on hydraulic press work. Man experienced in hydraulics, capable of making designs and drawings for special presses as veneer, binder board, hot plate presses, etc. Location, Pennsylvania.

190 Foremen experienced in the manufacture of rubber articles for European concern as listed in position 108.

192 Production engineer or mechanical superintendent for pulp mill; man with technical training and practical experience, familiar with modern methods of machine shop management, etc. Name confidential. Apply by letter.

205 Draftsman experienced in the design of bending rolls and who has had actual work in this line. Location, Southern States.

282 Machinery salesman, preferably one experienced in line of refrigerating machinery. Location, Philadelphia, with occasional trips within one hundred miles.

313 Detail draftsman for chemical work; must have some knowledge of chemistry. Apply by letter. Location, New York.

314 Draftsman for wood factory building; must be familiar with piping and belt drives. Apply by letter. Location, New York.

323 Live company engaged in manufacture of projectiles want high grade engineers for important positions. Prefer men with similar experience. Name confidential.

324 Three or four competent men to act as foremen in manufacturing plant in assembling of mechanical parts of munitions. Salary $100 to $125 a month. Location, New Jersey.

320 Young mechanical engineer with one or two years' experience in shop practice, wanted for drafting and testing work with concern doing general foundry and light machine shop work. Testing work will be mainly on power and heat transmission and the economical operation of mechanical devices in the shops, and for the first few months drafting out the general arrangement of the foundry, shops and apparatus. Give references and salary expected. Location, Middle West.

333 Machinist, pattern maker, draftsman and designer wanted as shop assistant for New Jersey concern. Salary to start, $30.

336 Draftsman with at least five years' experience in machine design, pipe work, etc. Salary, $125 month. Location, New Jersey. In applying state record of positions held and dates.

345 Massachusetts manufacturer of small electrical apparatus in quantities, requires the services of an assistant purchasing engineer for inspection of incoming materials; requires thorough familiarity with insulating and composition casting materials with practical knowledge of metal working and similar machinery. In applying give details covering age, nationality, education, practical experience, salary.

352 Machine shop foreman experienced in the building and manufacture of metal lathes. Salary, $2500 or more, depending on experience and ability to produce results. Location, Middle West.

353 Draftsman and one checker on open hearth, Bessemer and power plant work. In applying give full details of experience, references and salary expected. Location, Chicago.

356 Night superintendent thoroughly experienced in machine shop practice as applied to the manufacture of automobile parts and fairly well versed in the principles of efficiency management. Location, Chicago.

357 Salesman experienced in marketing high grade hot rolled electric and open hearth steel specialties; one having sufficient knowledge and information to post operation in securing proper tonnage for mills. In applying state age, experience and salary expected.

358 Draftsman experienced in design of steel pulleys; must be accurate, rapid and industrious. Salary about $25. State age, experience, previous employers and references. Location, Massachusetts.

362 Recent engineering graduate as research assistant in engineering library. Knowledge German and French essential. Location, New York. Library experience desirable, but not necessary.

365 Foreman for machine shop. Prefer one who has had eight or ten years' experience in gas engines or automobile motors, in modern factories and who is familiar with modern practices, who can get out production and understands thoroughly the handling of modern jigs and equipment. In applying give experience, salary desired to start, and references. Location, Ohio.

366 High grade draftsman competent to take charge of a number of men and do own calculating, with at least ten years' experience in drafting room. Location, Pennsylvania.

369 Plant engineer or millwright as superintendent for a plant employing approximately one thousand men; technically trained man preferred with several years experience in plant maintenance, development of ideas, erection of new buildings, etc. Record must show successful previous connections. Salary proportionate to experience and ability. Location, Middle West.

370 Young graduate engineer as salesman for water purification apparatus, filters and softeners for industrial and municipal supplies in New York and vicinity. Preference given to one who has good working knowledge of inorganic chemistry and with selling experience. In applying give full details of age, education, experience and salary.

372 Young engineer about thirty years of age who has studied efficiency work and with some experience in organizations doing such work. Excellent opportunity for industrious, intelligent and tactful man to get results without affecting present organization and introducing too much "system"; salary, $1500 to $2000 to start. Location, Connecticut.

376 Technical graduate, with one or two years' experience; to act as an assistant in steam engineering and general power work. State qualifications in detail and salary expected. Location, Cleveland, Ohio.

381 Experienced machine tool designer, prefer man with planer experience. In applying furnish records, salary expected and when ready to report for duty. Location, New Jersey.

384 Expert on power plant work and equipment with valuable patents in that line, strong personality, excellent executive and salesman, desires to invest several thousand dollars in established engineering enterprise or form partnership with consulting engineer. Advertiser is also ready to act as consulting engineer to engineering concerns.

385 Draftsman and assistant engineers familiar with mill construction, power plant design and industrial engineering. Apply by letter, stating experience, education, when and where born, nationality of parents, married or single, former employers, salary expected, and when available.

386 Tool designer, accustomed to heavy machine tool work. Location, Illinois.

387 Assistant factory superintendent; technical graduate and man with experience in handling men and in the production of small accurate work. Salary, $2500 to $3000 to start, but dependent largely on ability. Location, Connecticut.

388 Capable tool designer who is resourceful and can follow his own work through to completion. Man with practical shop experience as well as technical education. Location, Connecticut.

390 Designers and detailers for drawing room in Boston doing printing press work. Printing press experience not essential. Applicants must be careful, industrious and have sound mechanical knowledge.

391 Mechanical draftsman with blast furnace and rolling mill experience. Location, Pennsylvania.

394 Superintendent, machine tools, foundry and machine shop, employing 900 men. Prefer good executive to a mechanical expert; must have shown ability in factory management. Salary not limited. Apply by letter. Name confidential.

397 Competent shop superintendent or general machine shop foreman. Salary, $150 to $200 a month, according to ability. Location, Ontario, Canada.

MEN AVAILABLE

L-347 Member, age 35, technical training in mechanical, electrical and building construction course, Lowell Institute, Boston. Three years experience in drafting room and machine shop on steam pump work; ten years experience in charge of drafting room and design of steam boilers and steel plant work in Massachusetts, desires permanent position with opportunity for advancement with manufacturing concern, large central station power company or consulting engineer. Location preferably Boston.

L-348 Sales engineer with technical education and over five years practical experience (past four years with one concern), would like to communicate with first class manufacturing concern having an opening as manager or assistant. At present employed.

L-349 Technical graduate, age 28, dependable, progressive with thorough, practical shop and engineering department experience, desires position as assistant to superintendent.

L-350 Associate-member, M. E., age 38, expert in interchangeable manufacturing, sheet metal stamping and evolution of shapes; economic production of duplicate parts, light mechanical devices and machinery. National reputation as mechanical expert and consulting engineer, author of numerous standard mechanical text books; developer and perfector of machines and devices for commercial efficiency and success, desires position as production engineer where ability to eliminate costs, operations and intricate mechanisms and effect maximum efficiency and output at minimum cost will earn $4000 per year, and more when results justify increase.

L-351 Ordnance engineer, member, age 32, married, M. E., degree 1913, several years civilian employee of Ordnance Department, U. S. Army, experienced in design of various kinds of ordnance including guns, carriages, ammunition vehicles, ammunition and familiar with the design of machine rifles and their equipment, desires position in connection with the design and manufacture of ordnance.

L-352 Member, with experience in the design of locomotives and cars, and one who has made a study of the organization and handling of men and also expert examination of properties in order to bring them to a high point of efficiency, desires position as manager of large manufacturing concern.

L-353 General manager or superintendent of foundry, has had charge of some of the leading foundries of the country, capable of handling any foundry proposition, desires position.

L-354 Mechanical engineer, Stevens graduate, 1900, twelve years' mechanical superintendent, three years assistant manager, of large manufacturing plant; thoroughly versed in design and construction of mill buildings, installations and economical operation of electrical generators and motors, engines, boilers and manufacturing machinery, desires position. Vicinity of New York preferred.

L-355 Mechanical engineer, broad shop and office experience, expert in the manufacture of shrapnel and all sizes of high explosive shells, desires opening as organizer and manager of concern taking up shell work, or allied parts.

L-356 Mechanical engineer, age 33, married, graduate in mechanical engineering, eleven years' experience, four years as mechanical engineer in charge of design and construction of various machinery, has had experience in machine shop, inspection and testing, desires position as mechanical engineer, superintendent, chief draftsman or other executive position.

L-357 Junior, age 30, married, M. E. graduate, six years' designing experience in automobiles, motor trucks, production tools, small punch and die work, a large variety of special and semi-automatic machinery and inspection gages; possessed of sound originality and knowledge of tool room practice, careful and systematic, desires position in efficiency or production department.

L-358 Junior member, technical graduate, wishes connection with manufacturing firm which is about to make extensive addition to its plant as a representative of the owner to supervise the work and layout of the contractor, engagement to terminate when contract is finished to the satisfaction of the owner.

L-359 Practical and educated man of broad experience in manufacturing duplicate parts on the interchangeable basis, would like to hear from reliable firms with a view to securing the services of a live up-to-date executive, especially trained in the handling of difficult problems on all kinds of automatic machines and the die-casting of duplicate parts.

L-360 Technical graduate, wide experience as railway mechanical engineer, machinist, motive power draftsman and mechanical engineer, desires position along these lines, or one as mechanical inspector, assistant superintendent motive power, or assistant to general manager. Location, immaterial.

L-361 Technical graduate, age 31, nine years' broad experience in designing, manufacturing and testing special machinery, also delicate instrument work, thoroughly familiar with drawing office methods, pattern, foundry and machine shop practice, good executive, can handle correspondence, and draw up specifications, desires position. Location, immaterial.

L-362 Member, specializing in the installation of scientific management, seeks engagements in that line. Speaks Spanish fluently and would accept engagements in Latin America for the investigation of the efficiency and possibilities of improvement of enterprises, or would do betterment work.

L-363 M. E. graduate, two years general work and three and one half years' experience handling men, at present department foreman in large ammunition plant, desires responsible position with manufacturer of metal products.

L-364 Two young engineers, graduates M. E. and E. E., four years' sales and management experience, are open for attractive sales or manufacturing proposition. Want territorial agency, preferably New England for live-wire commodity. Extensive acquaintance among manufacturers. Capital investment possible.

L-365 Member, age 37, manufacturing plant construction and operating experience, also purchasing and structural steel estimating, two years as mechanical engineer with packing house, now engineer and traveling superintendent for a group of cotton oil mills. Salary $3600. No traveling.

L-366 Junior member, seven years' experience in design of oil engines, jigs, tools, power plant details, and as executive in charge of a small food project, desires connection with engineering or manufacturing concern.

L-367 Associate-member, graduate engineer, broad selling experience in steam specialty line, covering territorial representation, special representation in building up agent's territories, sales management, sales distribution and advertising, also some experience in manufacturing, desires position with concern in need of such a man to grow up with the business.

L-368 Member, technical graduate, ten years' experience in general engineering work with prominent consulting engineers, accustomed to responsibility and control, familiar with inspection and tests of materials and power equipment, fuel combustion, power production, plans and specifications, twelve years' experience in machine shop work, desires executive position with responsible firm or consulting engineer.

L-369 Works manager, age 40, with large and long established company manufacturing power equipment, twenty-two years general shop experience, having handled men for fifteen years, experienced in large production, having supervised from fifteen hundred to eighteen hundred men, desires to make a change.

L-370 Student member, M.E. graduate, Columbia 1915, with shop drafting room and power plant experience, employed at present, but desires to connect with an engineering or manufacturing concern in or about New York, with whom there is a chance for advancement.

L-371 Gas engine detailer, graduate mechanical engineer, 1911, age 26, shop experience erecting and testing engines and tractors, operating in field, detailing, wants further experimental drafting. Location, Middle West.

L-372 Member, South American, reliable, capable sales engineer, five years with present connection prominent Eastern jobbing house, sales, conversant with Spanish language

and understands the Latin people, have had considerable business experience and can efficiently represent manufacturers, hardware, mill and railroad supplies, agricultural or machinery lines, desires correspondence from concerns interested in developing South American business. Can furnish unquestionable references.

L-373 Member, graduate M.I.T., age 32, with special experience in power station work, heating and ventilating systems and electrical work, both in design and installation, desires position as mechanical engineer or superintendent of construction.

L-374 Mechanical engineer, graduate Columbia 1912, experienced in design and construction work, desires permanent position, preferably in sales or where there is a chance to work into sales or commercial end of business. Location, immaterial. Salary, $1500.

L-375 Junior member, mechanical graduate 1913, one year shop work, eighteen months drafting and designing, four months in responsible charge of laying water mains, desires position with construction contractor. Available in December.

L-376 Manufacturer's agent, experienced and competent, invites correspondence and investigation by those who desire a live representation in Chicago district.

L-377 Graduate mechanical engineer, twenty years' active experience, rising from shop and drafting room to chief engineer in charge of design, construction, maintenance and operation of large industry; long experience in steel works, also in heavy and medium heavy machinery design and operation, purchasing and inspection. Aggressive executive, thorough, economical and particularly successful in overcoming troubles and improving operating conditions as well as working out original problems of design and carrying through to a finish a complete enterprise, desires to change after long service in present position. Terms moderate.

L-378 Member, technical graduate, age 37, married, eleven years' practical experience in U. S. and abroad in general power station design, engineering and construction, also five years' experience in engineering, administrative and sales department of manufacturing corporations, desires to make connection with manufacturing company as purchasing engineer or executive position. Would eventually be able to invest some capital in right proposition. Has thorough knowledge of German, working knowledge of French. At present employed. Location preferred on Pacific Coast.

L-379 Associate member, Lehigh University graduate in mechanical engineering, with eighteen years' varied experience in mechanical, electrical and civil engineering lines, involving design, supervision and direct charge of construction work, plant operation, purchasing, reports, etc., all in connection with electric railways, lighting plants, power and industrial plants, wishes an executive position as manager, superintendent, or sales engineer, with larger field and responsibility. At present employed. Southern location preferred.

L-380 Junior member, age 26, technical graduate 1912, two years in testing department of large eastern electrical manufacturer, and experience with contracting concern, desires position with company operating power plants and street railways in middle west. Salary, $1200. At present employed.

L-381 Member, experienced in the manufacture of guns, small tools and machinery desires change. Highly successful as an executive in getting quality goods at low cost. Now superintendent of factory building high grade machinery.

L-382 Man of wide practical experience in inventing, designing and constructing special machinery would like a position along these lines. Salary, $3000.

L-383 Member experienced in power plant and shop work, responsible charge of estimating, production and costs in large concerns, some teaching experience; five years active participation in welfare and social work in industrial plants.

ACCESSIONS TO THE LIBRARY

This list includes only accessions to the library of this Society. Lists of accesions to the libraries of the A.I.E.E. and A.I.M.E. can be secured upon request from Calvin W. Rice, Secretary of Am. Soc. M. E.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Report of of the Committee to formulate standard specifications for the construction of steam boilers and other pressure vessels and for their care in service known as the Boiler Code Committee. Rules for the Construction of Stationary Boilers and for allowable working pressures. ed. 1914. *New York, 1915.* Gift of A. M. S. M. E.

——— Condensed catalogue of mechanical equipment, 1915. *New York, 1915.* Gift of A. S. M. E.

BALL BEARINGS, B. D. Gray and H. Wickland. Presented by B. D. Gray, April 14, 1915, before Electric Vehicle Association of America, at Philadelphia. Gift of Hess Bright Mfg. Co.

CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE. Growth of Internationalism in Japan. Publication no. 6. *Washington, 1915.* Gift of Carnegie Endowment for International Peace.

CONVERSION CHART. Merl R. Wolfard and C. K. Carpenter, *New York, J. Wiley & Sons, 1915.* Gift of publishers. Price $ .25 net.

A chart 12x34 on logarithmic co-ordinate paper. By means of this chart, conversions between units of work, pressure, time or temperature, as well as surface, area, weight or mass conversions for all common units, including metric, may be quickly made. W. P. C.

COOLING PONDS FOR CONDENSING ENGINES. L. H. Parker. *Boston, 1915.* Gift of Spray Engineering Company.

ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM. S. P. Thompson, ed. 7. *New York, 1915.* Gift of Macmillan Company.

Profesor Thompson has completely revised the book for this edition. There is a new chapter on Wireless Telegraphy, and another on the modern conception of the Electron. W. P. C.

THE EVILS OF GOVERNMENT OWNERSHIP. J. Bourne, Jr. Gift of American Electric Railway Association.

HIGH EXPLOSIVE SHELLS. A reprint of important articles presented in the American Machinist, from June to October, 1915. Gift of American Machinist.

HYDRO-ELECTRIC DEVELOPMENT OF THE COHOES COMPANY, Cohoes, N. Y. Reprinted from General Electric Review. Gift of Sanderson & Porter.

INTERNATIONAL IRRIGATION CONGRESS. Official proceedings of the 21st, 1914. *Ottawa, 1915.* Gift of Canada. Department of the Interior-Irrigation Branch.

MACHINE DESIGN. A. W. Smith and G. H. Marx. ed. 4. *New York, J. Wiley & Sons, 1915.* Gift of publishers. Price $3.00 net.

The text has been thoroughly revised in this edition, and the results of new investigations of machine elements have been included. W. P. C.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION. Proceedings of Annual Convention, 11th-13th. *New York, 1912-14.*

——— PROCEEDINGS OF SEMI-ANNUAL CONVENTION, 1912-15. *1912-15.* Gift of National Machine Tool Builders' Association.

NEW ORLEANS. SEWERAGE AND WATER BOARD. Hurricane of Sept. 29, 1915, and subsequent heavy rainfalls. Gift of Sewerage and Water Board of New Orleans.

ÖSTERREICHISCHER INGENIEUR UND ARCHITEKTENVEREIN. Jahrbuch 1915. *Wein, 1915.* Gift of Österreichischer Ingenieur und Architektenverein.

PRACTICAL SURVEYING, for surveyors' assistants, vocational and high schools, Ernest McCullough. *New York, Van Nostrand Co., 1915.* Gift of publishers. Price $2.00.

A simply worded text book, presupposing only a knowledge of arithmetic. W. P. C.

PRESS REFERENCE LIBRARY. (Western Edition.) Notables of the West. vol. II. *New York-Los Angeles, 1915.* Gift of F. R. Freeman.

SCHWEIZERISCHER INGENIEUR UND ARCHITEKTEN VEREIN. Geschäftsbericht für die Berichtsperiode von Ende Juli 1913 bis Ende Juni 1915. *Zurich, 1915.* Gift of Schweizerischer Ingenieur und Architekten Verein.

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——— President's Sixth Annual Report. Bulletin vol. 24, no. 68, July, 1915. *Pasadena, 1914-15.* Gift of Throop College.

U. S. Dept. of Agriculture. Yearbook, 1914. *Washington, 1915.* Gift of C. W. Rice.

The Valley Pipe Line Company's Oil Pipe Line. Coalinga Oilfields to Martinez, California. Reprint from Journal of Electricity, Power and Gass, Sept. 4, 1915. Gift of Sanderson & Porter.

EXCHANGES

American Society of Civil Engineers. Transactions vol. LXXVIII. *New York, 1915.*

Institution of Civil Engineers of Ireland. Transactions vol. XLI. *Dublin, 1915.*

Purdue Engineering Review, vol. XIII, 1913. *Lafayette, 1913.*

U. S. Patent Office. Annual report of the Commissioner, 1914. *Washington, 1915.*

TRADE CATALOGUES

Daimler-Motoren Gesellschaft. *Stuttgart, Germany.* Mercedes Cars.

Edge Moor Iron Co. *Edge Moor, Del.* General Catalogue no. 52. Water Tube Boiler. *1915.*

Flannery Bolt Co. *Pittsburgh, Pa.* Staybolts. *Oct., 1915.*

Goldschmidt Thermit Co. *New York City.* Reactions. vol. 8, no. 3. *1915.*

Ingersoll-Rand Co. *New York, N. Y.* Catalog no. 76. Water lifted by compressed air. Calyx core drills. *July, 1915.*

Leschen, A. & Sons Rope Co. *St. Louis, Mo.* Leschen's Hercules. *Oct. 1915.*

McNab & Harlin Manufacturing Co. *Paterson, N. J.* Monthly Herald. *Oct. 1915.*

Rice, Cyrus W. *Philadelphia, Pa.* Catalogue describing the Cyrus W. Rice Intermitting Circulating-Aerating-System for the Mechanical and Chemical Clarification and Purification of Water and Sewage Without Filtration.

Underfeed Stoker Co. of America. *Chicago, Ill.* Publicity Magazine. *Nov. 1915.*

Walworth Mfg. Co. *Boston, Mass.* Walworth Log. *Nov. 1915.*

Williams Patent Crusher & Pulverizer Co. *St. Louis, Mo.* Bulletin 107. Durability of Williams Crushers and Pulverizers.

——— 112. Conglomerate ore.

UNITED ENGINEERING SOCIETY

American Sewerage Practice. Vol. II—Construction of Sewers. Leonard Metcalf and H. P. Eddy. *New York, 1915.*

Analysis of Non-ferrous Alloys. Fred Ibbotson and Leslie Aitchison. *London, 1915.*

Berichte der Schweizerischen Studienkommission für elektrischen Bahnbetrieb, Dr. Wyssling. Heft. 1. *Zürich, 1908.*

Bibliography of Colorado Geology and Mining from the earliest explorations to 1912. Colorado Geological Survey. Bulletin no. 7. *Denver, 1914.* Gift of Survey.

Blast Furnace and the Manufacture of Pig Iron. Robert Forsythe. Ed. 3. *New York, 1913.*

Boiler, Tank and Stack Manufacturers of the United States and Canada. Directory, 1914. Gift of American Boiler Manufacturers Association.

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Colorado. Geologic map of Colorado, 1913.

——— Topographic map of Colorado, 1913. Gift of Colorado Geological Survey.

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Concrete Steel Construction. H. T. Eddy and C. A. P. Turner. Part I—Buildings. *Minneapolis, 1914.*

Dictionary of English and German Military Terms. C. F. Atkinson. *London, 1915.*

Discoveries and Inventions of the Twentieth Century. Edward Cressy. *New York, 1915.*

Dyestuffs and Coal Tar Products; their chemistry, manufacture and application. Thomas Beacall and others. *London, 1915.*

Electricity in Gases. J. S. Townsend. *Oxford, 1915.*

Elements of Electricity for Technical Students. W. H. Timbie. *New York, 1914.*

Examination of Hydrocarbon Oils and of Saponifiable fats and waxes. D. Holde and E. Mueller. *New York, 1915.*

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Geology of the Monarch Mining District, Colorado. Preliminary report. Colorado. Geological Survey. Bulletin no. 1. *Denver, 1910.* Gift of Survey.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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[1] A complete list of the officers and committees of the Society will be found in the Year Book for 1915, and in the January and July 1915 issues of The Journal.

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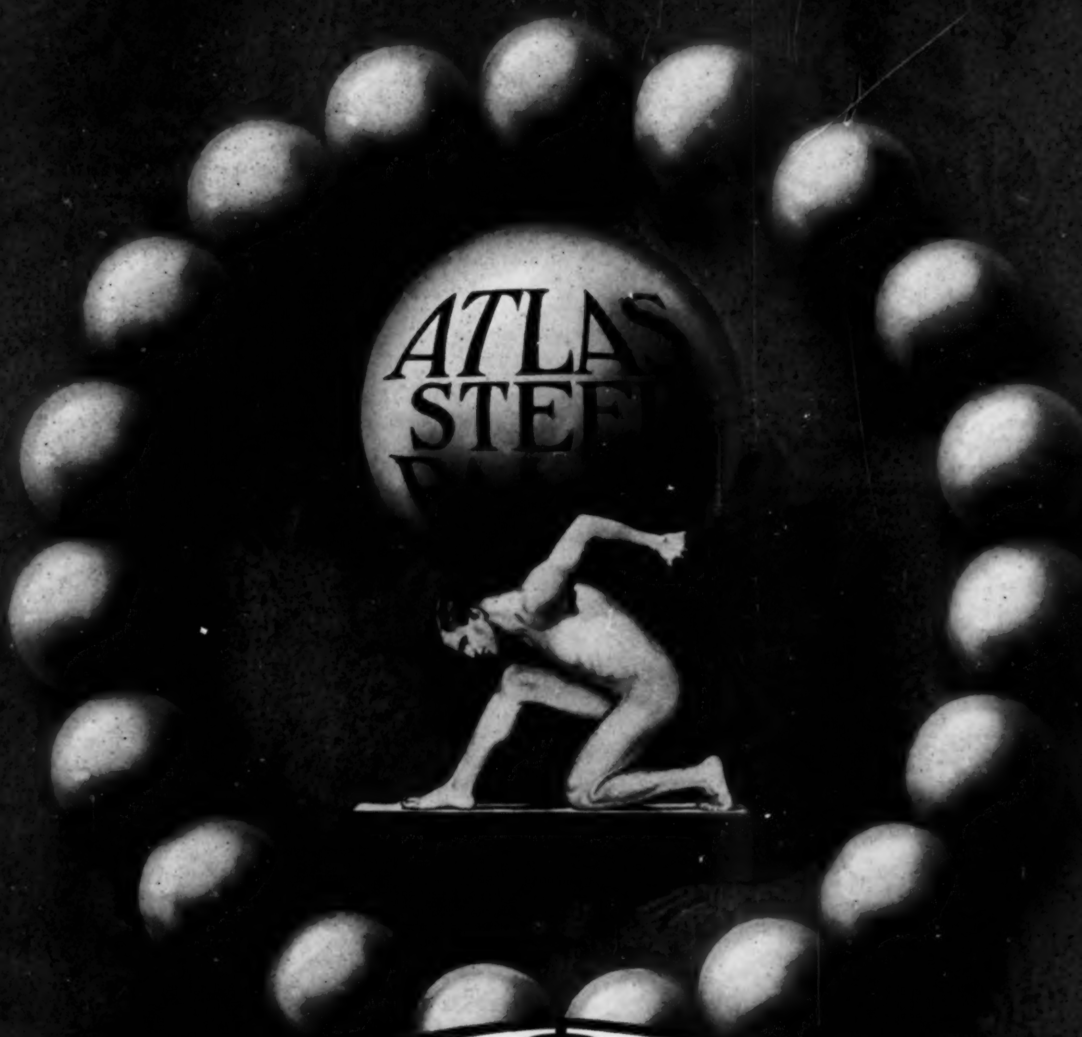

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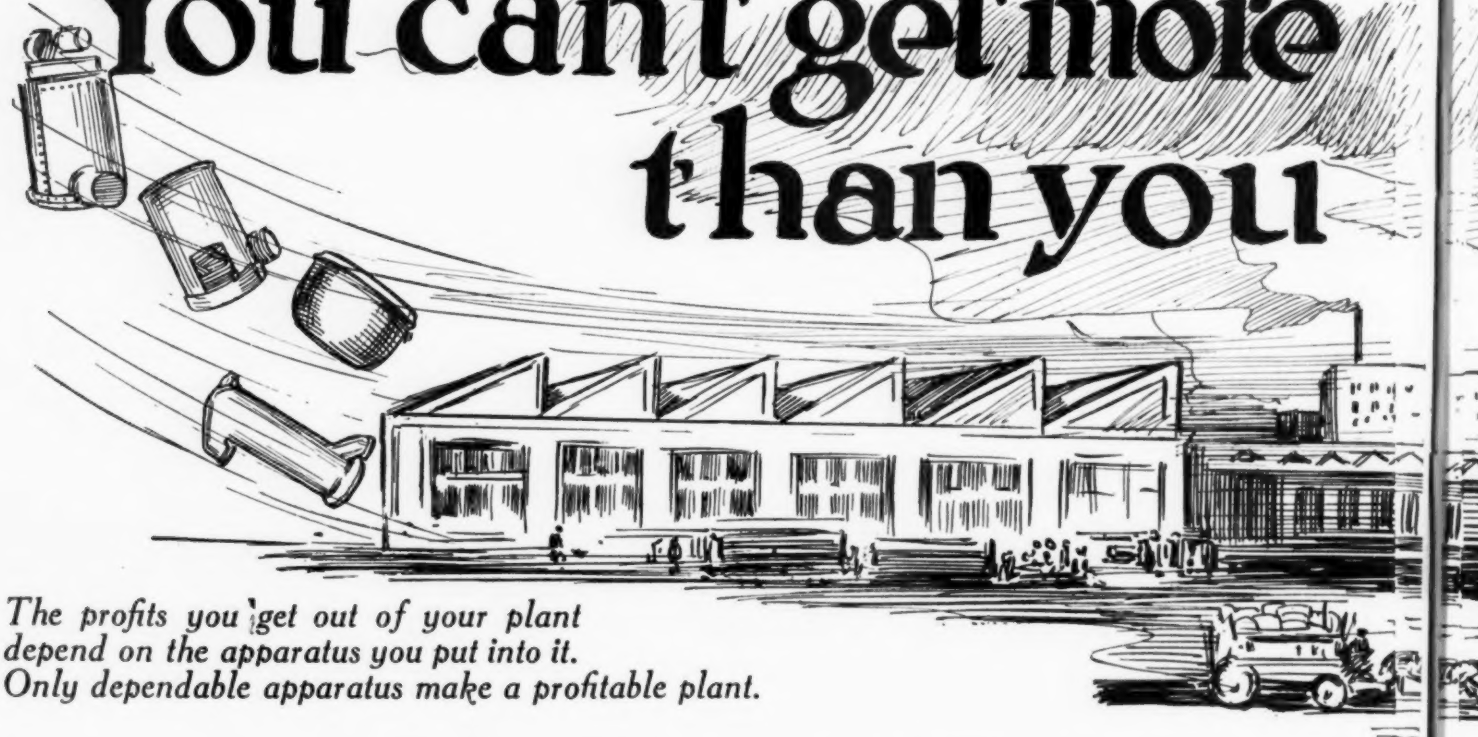

The profits you get out of your plant depend on the apparatus you put into it. Only dependable apparatus make a profitable plant.

"BUFLOKAST"

for the manufacture of anilines, phenol, picric acid, Beta-napthol and kindred organic materials are profitable, for two reasons:

1. Because "Buflokast" Apparatus is dependable.
2. Because we have the experience required to do for you all or any part of the work of designing, constructing and operating the equipment under a guarantee as to quantity, quality and cost.

This experience has enabled us to design and manufacture apparatus that is proof against the troubles some are now experiencing due to installing apparatus improperly designed and constructed. That is why we are constantly replacing other apparatus with "Buflokast" equipment.

"BUFLOVAK" VA

The line includes dryers for all materials—all of design and construction proved dependable and efficient in service—the kind that insures both quality and quantity of output.

Vacuum Shelf Dryers for drying materials in pans or trays.

BUFFALO FOUNDRY and

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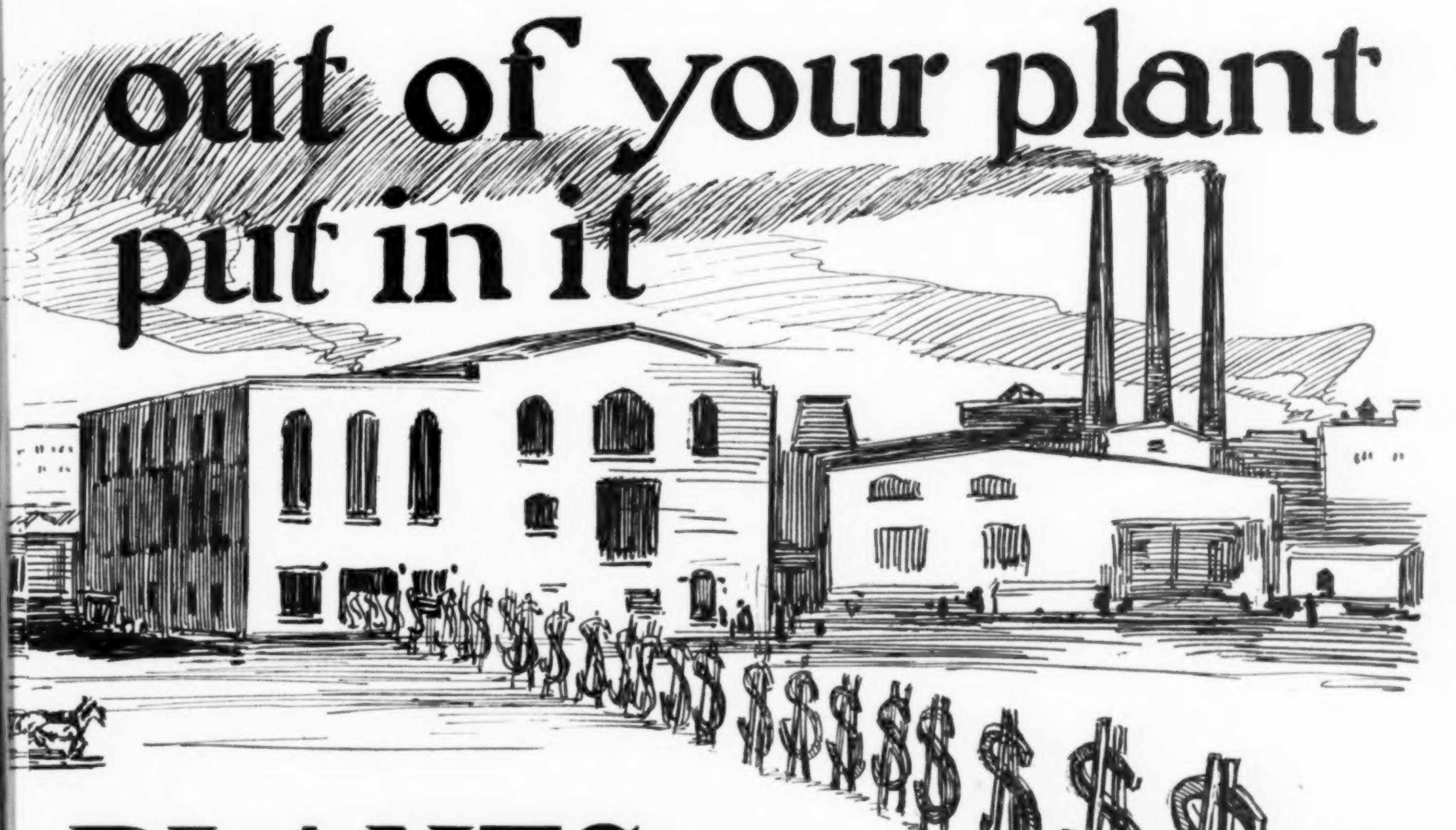


PLANTS

Conversely, our experience in making successful APPARATUS enables us also to make successful PLANTS. Neither part of the industry presents new problems or new responsibilities to the organization that stands behind the word "Buflokast."

"Buflokast" apparatus is not built to meet a price but for efficiency and durability.

This organization has worked out processes superior to European practice in certain features. It is by close attention to details and broad knowledge of the field that successful PLANTS and successful APPARATUS are best secured by making them "Buflokast."

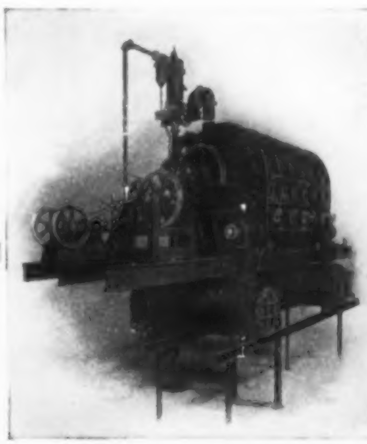
Among the many varieties of apparatus which we manufacture are

CUUM DRYERS

Vacuum Rotary Dryers, for any material that permits being tumbled while drying.

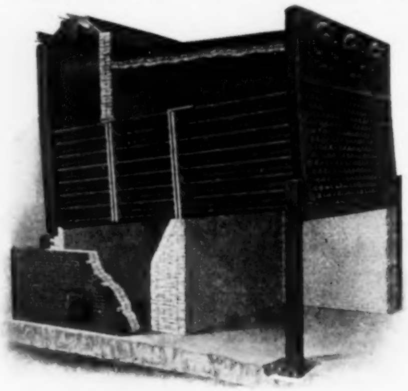
Vacuum Drum Dryers, for drying any liquids containing solids.

Condensers, Dry Vacuum Pumps, Solvent Reclaiming Apparatus, Impregnating Apparatus.



MACHINE COMPANY

Buffalo, New York



THE EDGE MOOR WATER TUBE BOILER

Especially Suitable for Large Power Plants

Steel construction throughout. Straight tubes. All hand-holes elliptical, their covers internal and removable through their own openings. Unrestricted circulation permitting forcing of fires with safety and economy.

Send for Bulletins on Performance

EDGE MOOR IRON COMPANY
Edge Moor, Delaware
New York Boston Chicago San Francisco

A. S. M. E. Condensed Catalogues Mechanical Equipment See Volume for 1915

Heine

ENGINEERS:

Send for a copy of the book

"BOILER LOGIC"

It discusses the Design of Heine Boilers and Their Operation. Also ask for pamphlets "Superheating and Large Heine Boilers."

HEINE SAFETY BOILER CO.
2465 East Marcus Ave., St. Louis, Mo.

Boilers

Genuine Charcoal Iron Boiler Tubes

MADE from the same grade of Charcoal Iron which we formerly furnished the Allison Manufacturing Company for all their tubes, are practically free from pitting and corrosion, and will withstand 400° more heat than steel tubes.

We are in position to furnish these tubes to conform to requirements of the A. S. M. E. Boiler Code.

PARKESBURG IRON COMPANY
Parkesburg, Pennsylvania
NEW YORK OFFICE, . . 30 CHURCH STREET

SPRINGFIELD BOILERS

Springfield Water Tube Boilers

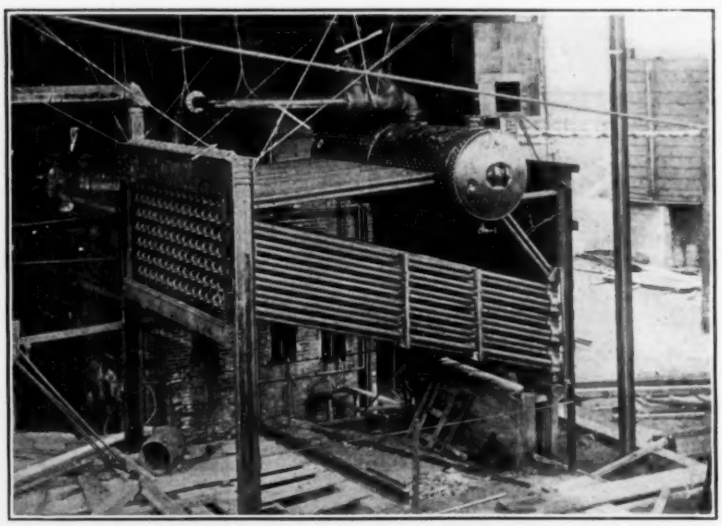
SECTIONAL—SINUOUS HEADERS
NO Staybolts—NO Braces—NO Bent Tubes
Of ALL STEEL Construction

Each section suspended independent of all other sections.

Hand holes have inside plates of drop forged steel each covering four tubes.

65% less hand holes than other horizontal W. T. boilers.

Tubes pitched 15° and large circulating area between headers and drum insures rapid steaming.



Occupy less space and require less brick than other horizontal W. T. boilers.

Having about 97% *Tube* heating surface—drum of large diameter and special dry pipe insures dry steam.

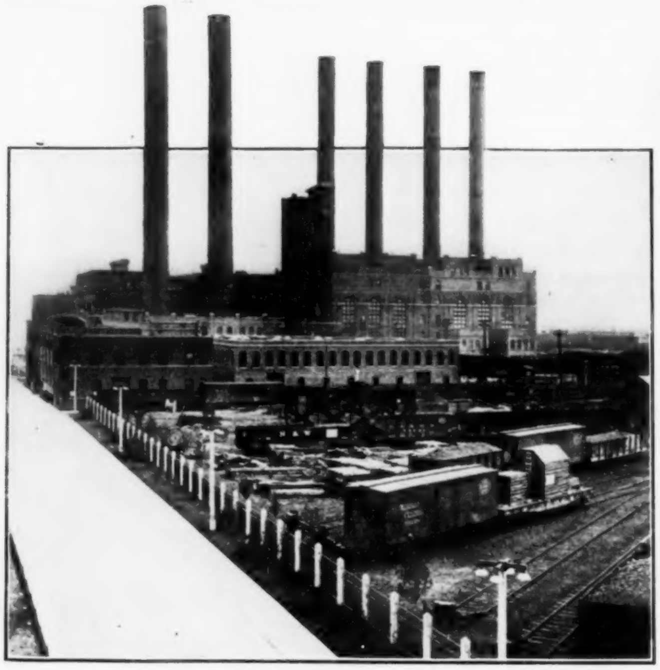
Baffles are indestructible and permit removal of any tube without disturbing other tubes or baffles.

Illustration of one 605 H.P. Boiler being erected at the plant of the Indiana Steel & Wire Co., Muncie, Ind.

Write for further information

Springfield Boiler & Manufacturing Co.

Springfield, Illinois



...operating log ... previously given.

The flexibility of the Taylor stoker is shown by the ease with which these wide variations in load are carried. The drop in the load at noon and the evening peak are

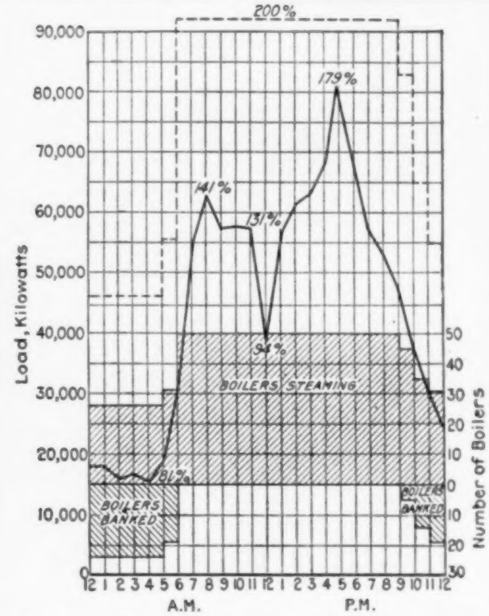


FIG. 2. LOAD CURVE FOR DEC. 9, 1914, AND BOILER CHART

carried with the same degree of ease, and the transition from one to the other involves no more increased activity in the boiler room than that actually required for normal operation.

The operating engineer is supplied also with a schedule ... number of turbo-generators to run ...

Power Sept. 21 P. 415

Norman G. Reinicker

says:—

He says it in one of his recent articles on boiler operation at Delray.

He is not arguing for the TAYLOR STOKER; he is simply stating a matter of fact as he sees it.

And he says exactly what we have emphasized a hundred times over—

(*a*) That the TAYLOR STOKER is the acme of flexibility.

(*b*) That the labor cost at the hour of greatest overload is no whit more than that for operation at rating or under.

Remember what the fruit of this flexibility is:—a concentrated boiler plant, reduced fixed charges and operating expense, a lessened cost of power production.

The designing engineer should not fail to study Detroit Edison design and practice before laying out his plant. Consult us for a list of other installations.

American Engineering Co.

Philadelphia

The Taylor Stoker

The Sturtevant Turbo-Undergrate Blower will increase the steaming capacity of your boilers. You can burn slack or screenings with economical results and even sawdust, shavings, and other refuse assures constant steam pressure—Easily installed. Catalog 214-AS is yours for the asking.

B. F. Sturtevant Co., Hyde Park, Boston, Mass.
and all principal cities of the world.

Selling Agents for the Sanford-Riley Stoker Co., Ltd. "The Riley Stoker."

Morehead Back to Boiler SYSTEM

For Feeding Boilers

Returns the condensation with its ***full*** heat content direct to boilers—***and without pumps.*** Every steam user needs the ***Morehead System.*** Can be used with any kind of service

Get complete information from our Engineers. Write today.

MOREHEAD MFG. CO. Department 7 DETROIT, MICH.

164

A CHIEF ENGINEER
Wrote This

Gentlemen:

The following is from my log sheets Sept. 30th, 1915:

2—500 H.P. B. & W. boilers in operation.

Decrease in coal consumption since January 1st, 1915 (when Diamond blowers were installed), 217.5 tons or 6.5 per cent.

Increase in output for same period 294,682 KW-Hrs., or 25 per cent.

SAVING IN COAL ALONE $1196.25

This increase and decrease is over same period last year.

The blowers have given satisfaction in every respect. They have not been touched for any repairs or adjustments of any kind since put in operation.

The ease with which they are operated is a point that pleases me, as I know there is no excuse for dirty tubes.

Yours very truly,
(Signed) A. J. FISHER,
Chief Engineer.

Miami Electric Light & Power Co.,
Miami, Fla.

These are not extraordinary results by any means. They are only representative of results that 40,000

Diamond Soot Blowers

are producing.

Will you let us show you how at least equal and possibly even better results can be obtained in YOUR boiler plant? We assure you that a request for information will not obligate you in the least, and it may pave the way to a considerable saving in fuel and labor and a surprising increase in the efficiency of your boilers.

Write, right now, while the subject is fresh in your mind.

Diamond Power Specialty Co.
Detroit, Mich.

A. S. M. E. Condensed Catalogues Mechanical Equipment See Volume for 1915

SOOT BLOWERS TO SUIT EVERY TYPE OF BOILER

Steel encased boilers of the United Electric Light & Power Co., New York, where all side cleaning or dusting doors have been eliminated and Vulcan Soot Cleaners installed.

Eliminate Boiler Air Leakage by Using Vulcan Soot Cleaners

THERE is little use in installing air-tight steel casings on your boilers unless the numerous dusting or cleaning doors are eliminated at the same time. Experiments have shown that a great part of the leakage into boiler settings occurs around the cleaning doors where there are numerous unavoidable small openings, through which the air leaks into the setting.

Do away with such leaks and make your brick settings solid, or steel encased settings free from all openings, by installing Vulcan Soot Cleaners. There is a Vulcan Soot Cleaner for every type of commercial boiler.

Recently Vulcan Soot Cleaners have been installed in such well known plants as the Detroit Edison Co., United Electric Light & Power Co., New York, Public Service Corporation of New Jersey, Solvay Process, etc., etc.

Send for our forthcoming book on the Vulcan Soot Cleaner, and give us particulars of your boiler plant conditions, size and type of boilers, and location of stoker and baffling.

Vulcan Soot Cleaner Co.
A Million H. P. Equipt
Du Bois, Pa.

One of the largest collections of engineering literature in the world is the Engineering Library in the Engineering Societies Building, 29 West 39th Street, New York.

It comprises 65,000 volumes, including many rare and valuable reference works not readily accessible elsewhere. Over 1000 technical journals and magazines are regularly received, including practically every important engineering journal in the world in the mechanical, electrical and mining fields.

The library is open from 9 a. m. to 10 p. m., with trained librarians in constant attendance. Its resources are at the service of the engineering and scientific public.

The New Weston Instruments of Precision

Model 329 Portable Polyphase Electrodynamometer Wattmeter

An Instrument of Precision guaranteed to an accuracy of 1/2 of 1% of full scale value, on A. C. Circuits of any frequency up to and including 133 cycles and on circuits of any wave form.

Double ranges are provided for both current and voltage circuits. The current coils will withstand 100% overload indefinitely and the voltage ranges 60%, without readable error.

Other important features are the uniformity of the scales throughout the *entire* length, the effective shielding from external magnetic fields, and the perfect damping.

For complete information regarding Model 329 Wattmeters write for Bulletin 2002. Other models in this group are Model 310 Single-Phase and Direct Current Portable Wattmeter, described in Bulletin 2002; Model 370 A.C. and D.C. Ammeter, described in Bulletin 2003; and Model 341 A.C. and D.C. Voltmeter, described in Bulletin 2004.

Weston Portable Instrument Transformers are described in Bulletin 2001.

Weston Electrical Instrument Co.
49 Weston Ave., Newark, N. J.

New York, Boston, Philadelphia, Buffalo, Cleveland, Cincinnati, Chicago, St. Louis, Richmond, Denver, Detroit, San Francisco, Toronto, Montreal, Winnipeg, Vancouver

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There's a Trustworthy Thermometer for Every Purpose

It's stamped

H&M Tycos

May We Send Catalogues Covering Your Industry?

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INDICATING AND RECORDING
GAUGES
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THERMOMETERS—TEMPERATURE CONTROLLERS —PYROMETERS—TACHOMETERS—FLOW METERS

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THE FOXBORO CO.
Succeeding THE INDUSTRIAL INSTRUMENT CO.
FOXBORO, MASS., U. S. A.
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See Our Exhibit at Panama-Pacific Exposition. Palace of Mach'y, Cor. 3rd St. and Ave C₅, and Collective Gas Exhibit, Space 29.

Veeder Set Back and Locked Wheel COUNTERS

are absolutely reliable instruments for the recording of output from machines.

In their design special attention has been given to making an instrument which will operate with the greatest ease. They are furnished with the following forms of driving mechanism: Revolution, Direct Drive and Rotary Ratchet.

Complete catalogues showing over 25 different styles of counters mailed free upon request

THE VEEDER MFG. CO., Hartford, Conn.
16 Sargeant St.

A. S. M. E. Condensed Catalogues of Mechanical Equipment — See Volume for 1915

Makers of Cyclometers, Odometers, Tachometers, Tachodometers, Counters and Small Die Castings.

(Cut Half Size)

The "Locked Wheel" Counter, illustrated above, is similar to the Setback Counter except the number wheels are locked in all positions.

Especially useful where the work is paid for by the piece, as it may be connected up so the figures cannot be moved except by running the machine.

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• Alliance Machine Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
Wood & Co., R. D.
• Worthington, Henry R.

Aerial Tramways
(See Tramways, Wire Rope)

Air Brakes, Compressors, Filters, Receivers, etc.
(See Brakes, Compressors, Filters, Receivers, etc., Air)

Air-Jet Lifts
Schutte & Koerting Co.

Air Lift Pumping Systems
• Ingersoll-Rand Co.
• International Steam Pump Co.
Laidlaw-Dunn-Gordon Co.

Air Washers
General Condenser Co.
Sturtevant Co., B. F.

Alternators
(See Generators, Electric)

Ammeters, Voltmeters
(See Electrical Instruments)

Ammonia Condensers, Fittings, etc.
(See Condensers, Fittings, etc., Ammonia)

Anemometers
• Taylor Instruments Cos.

Anvil Blocks
• Hooven, Owens, Rentschler Co.

Arches, Ignition (Flat Suspended)
• Green Engineering Co.

Asbestos Products
Johns-Manville Co., H. W.

Ash Ejectors
(See Ejectors, Ash)

Ball Bearings, Gages, etc.
(See Bearings, Gages, Ball)

Balls, Steel
• Atlas Ball Co.

Barrows, Furnace Charging
Weimer Machine Works Co.

Bearings, Ball
Fafnir Bearing Co.
• Norma Co. of America

Bearings, Roller
• Norma Co. of America
Royersford Foundry & Machine Co.

Bearings, Self-Oiling
• Brown Co., A. & F.
• Caldwell & Son Co., H. W.
• Doehler Die-Casting Co.
• Falls Clutch & Machinery Co.
• Hill Clutch Co.
Jeffrey Manufacturing Co.
Royersford Foundry & Machine Co.
Webster Mfg. Co.
Wood's Sons Co., T. B

Bearings, Thrust
Fafnir Bearing Co.
• Hill Clutch Co.
• Norma Co. of America

Bells and Hoppers, Furnace
Weimer Machine Works Co.

Belt Dressing
Schieren Co., Chas. A.
• Texas Co.

Belt Lacing
Schieren Co., Chas. A.

Belt Tighteners
• Brown Co., A. & F.
• Caldwell & Son Co., H. W.
• Hill Clutch Co.
Webster Mfg. Co.
Wood's Sons Co., T. B.

Belting, Chain
(See Chains and Chain Links)

Belting, Conveyor
• Goodrich Co., B. F.

Belting, Rubber
• Goodrich Co., B. F.

Belting, Leather
Schieren Co., Chas. A.

Belting, Textile
• Goodrich Co., B. F.

Benches, Work
Manufacturing Equipment & Engrg. Co.

Bending Machines, Hydraulic
Morgan Engineering Co.
Wood & Co., R. D.

Blocks, Tackle
• Clyde Iron Works
• Hunt Co., Inc., C. W.
• Roebling's Sons Co., John A.

Blowers, Centrifugal
• General Electric Co.
• Southwark Fdry. & Mch. Co.
Westinghouse Machine Co.

Blowers, Fan
• Sturtevant Co., B. F.

Blowers, Pressure
• Lammert & Mann
• Roots Co., P. H. & F. M.
Sturtevant Co., B. F.

Blowers, Rotary
• Lammert & Mann
• Roots Co., P. H. & F. M.
Schutte & Koerting Co.
Sturtevant Co., B. F.

Blowers, Soot
• Diamond Power Specialty Co.
Vulcan Soot Cleaner Co.

Blowers, Steam
Schutte & Koerting Co.

Boiler Coverings, Furnaces, Tube Cleaners, Tubes, etc.
(See Coverings, Furnaces, Tube Cleaners, Tubes, etc., Boiler)

Boiler Compound
Johns-Manville Co., H. W.

Boilers, Heating
• Keeler Co., E.
• Smith Co., H. B.

Boilers, Internal Furnace
• Springfield Boiler & Mfg. Co.

Boilers, Locomotive
• Clyde Iron Works
Erie City Iron Works
• Lidgerwood Mfg. Co.

Boilers, Marine
• Almy Water Tube Boiler Co.
Babcock & Wilcox Co.
• Keeler Co., E.

Boilers, Return Tubular
Erie City Iron Works
• Keeler Co., E.
• Springfield Boiler & Mfg. Co.

Boilers, Vertical Tubular
• Clyde Iron Works
• Lidgerwood Mfg. Co.

Boilers, Water Tube
• Almy Water Tube Boiler Co.
Babcock & Wilcox Co.
• Edge Moor Iron Co.
Erie City Iron Works
Heine Safety Boiler Co.
• Keeler Co., E.
• Springfield Boiler & Mfg. Co.

Boilers Retubed
• Wendland Engrg. & Construction Co., C. F.

Bolt-Cutting Machines
Wells Bros. Co.

Boring and Drilling Machines
Manning, Maxwell & Moore, Inc.

Boring and Turning Mills, Vertical
King Machine Tool Co.

Brake Blocks
Johns-Manville Co., H. W.

Brass-Working Machine Tools
(See Tools, Brass-working Machine)

Brewers' and Bottlers' Machinery
• Vilter Mfg. Co.

Bridge Tramways
(See Tramways, Bridge)

Bridges
Toledo Bridge & Crane Co.

Buckets, Elevator
• Caldwell & Son Co., H. W.
Jeffrey Manufacturing Co.
• Link-Belt Co.
Webster Mfg. Co.

Buckets, Grab
• Clyde Iron Works
• Hunt Co., Inc., C. W.
Jeffrey Manufacturing Co.
• Lidgerwood Mfg. Co.
• Link-Belt Co.
Orton & Steinbrenner Co.
Whiting Foundry Equip. Co.

Buckets, Self-Dumping
• Clyde Iron Works
• Hunt Co., Inc., C. W.
Orton & Steinbrenner Co.

Bulldozers
Wood & Co., R. D.

Burners, Gas
• Quigley Furnace & Fdry. Co.
Weimer Machine Works Co.

Burners, Oil
Best, W. N.
• Quigley Furnace & Fdry. Co.
Schutte & Koerting Co.

Burners, Powdered Coal
• Quigley Furnace & Fdry. Co.

Cabinets and Tables, Blue-Print
Manufacturing Equipment & Engrg. Co.

Cable, Wire
(See Rope, Wire)

Cable Railways
(See Railways, Cable)

Cables, Electrical
(See Wire and Cables, Electrical)

Cableways, Excavating
• Lidgerwood Mfg. Co.

Cableways, Hoisting and Conveying
• Lidgerwood Mfg. Co.

Calorimeters
• Sarco Engineering Co.

Calorimeters, Gas, Recording
Smith Gas Power Co.

Car Hauls, Cable and Chain
Jeffrey Mfg. Co.

Carriers and Elevators, Freight, Continuous
Jeffrey Mfg. Co.
• Link-Belt Co.
Mathews Gravity Carrier Co.
Webster Mfg. Co.

Cars, Cinder and Hot Metal
Weimer Machine Works Co.

Cars, Dump
• Hunt Co., Inc., C. W.
Weimer Machine Works Co.

Cars, Freight Elevator
Eastern Machinery Co.

Cars, Industrial Railway
• Hunt Co., Inc., C. W.
• Link-Belt Co.
Whiting Foundry Equip. Co.

Cars, Motor
• Hunt Co., Inc., C. W.

Castings, Brass and Bronze
Crescent Mfg. Co.
• Homestead Valve Mfg. Co.
Lunkenheimer Co.

Castings, Die-Molded
• Doehler Die-Casting Co.
• Veeder Mfg. Co.

Castings, Iron
• Brown Co., A. & F.
Buffalo Fdry. & Mch. Co.
Builders Iron Foundry
• Caldwell & Son Co., H. W.
• Central Foundry Co.
• Falls Clutch & Machinery Co.
Harrisburg Foundry & Machine Works
• Hill Clutch Co.
Holyoke Machine Co.
• Homestead Valve Mfg. Co.
• Hooven, Owens, Rentschler Co.
• Lidgerwood Mfg. Co.
Lunkenheimer Co.
Mesta Machine Co.
• Quigley Furnace & Fdry. Co.
Royersford Foundry & Machine Co.
Weimer Machine Works Co.
Wood & Co., R. D.

Castings, Semi-Steel
Buffalo Fdry. & Mch. Co.
Builders Iron Foundry
• Caldwell & Son Co., H. W.
• Hill Clutch Co.
• Hooven, Owens, Rentschler Co.
Lunkenheimer Co.
Mesta Machine Co.
Wood & Co., R. D.

Castings, Steel
Mackintosh, Hemphill & Co.
Mesta Machine Co.

Cement, Belt
Schieren Co., Chas. A.

Cement, High Temperature
Johns-Manville Co., H. W.

Cement Machinery
• Hill Clutch Co.
Power & Mining Mchy. Co.

Centrifugal Pumps
(See Pumps, Centrifugal)

Chain Drives
• Link-Belt Co.

Chain Grate Stokers
(See Stokers, Chain Grate)

Chains and Chain Links
• Caldwell & Son Co., H. W.
Jeffrey Mfg. Co.
• Link-Belt Co.
Webster Mfg. Co.

Channeling Machines, Mine and Quarry
• Ingersoll-Rand Co.

Charging Machines, Furnace
• Alliance Machine Co.
Morgan Engineering Co.

Chimneys, Steel
(See Stacks, Steel)

Chucking Machines
• Jones & Lamson Machine Co.
Le Blond Machine Tool Co.
• Warner & Swasey Co.

Chutes
• Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
• Link-Belt Co.

Chutes, Gravity Spiral
Mathews Gravity Carrier Co.

Circulators, Feed Water
Schutte & Koerting Co.

Circulators, Steam Heating
Schutte & Koerting Co.

Clamps, Pipe-Joint
Yarnall-Waring Co.

Clamps, Wire Rope
(See Wire Rope Fastenings)

Clutch Leathers
(See Leathers, Automobile)

Clutches, Friction
• Brown Co., A. & F.
• Caldwell & Son Co., H. W.
Eastern Machinery Co.
• Falls Clutch & Machinery Co.
• Hill Clutch Co.
Holyoke Machine Co.
Jeffrey Mfg. Co.
• Link-Belt Co.
• Moore & White Co.
Webster Mfg. Co.
Wood's Sons Co., T. B.

Coal and Ash Handling Machinery
• Caldwell & Son Co., H. W.
• Green Engineering Co.
• Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
• Link-Belt Co.
Orton & Steinbrenner Co.
Webster Mfg. Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1915 Volume*

Coal Crushers
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Link-Belt Co.
Orton & Steinbrenner Co.
Power & Mining Mchy Co
Webster Mfg. Co.

Coal Mine Equipments and Supplies
Jeffrey Mfg. Co.

Coal Mining Machinery
* Ingersoll-Rand Co.
Jeffrey Mfg. Co.

Coaling Stations, Locomotive
* Hunt Co., Inc., C. W.
* Link-Belt Co.
Webster Mfg. Co.

Cocks, Air and Gage
Ashton Valve Co.
* Crane Co.
* Jenkins Bros.
Lunkenheimer Co.
Walworth Mfg. Co.

Cocks, Blowoff
* Crane Co.
* Homestead Valve Mfg. Co.
Lunkenheimer Co.
Walworth Mfg. Co.

Cocks, Three-way and Four-way
* Crane Co.
* Homestead Valve Mfg. Co.
Lunkenheimer Co.
Walworth Mfg. Co.

Coils, Pipe
National Pipe Bending Co.
* Vilter Mfg. Co.

Coke Oven Machinery
* Alliance Machine Co.

Cold Storage Plants
* De La Vergne Machine Co.

Collars, Shafting
* Caldwell & Son Co., H. W.
* Hill Clutch Co.
Royersford Foundry & Machine Co.
Wood's Sons Co., T. B.

Collectors, Dust
Sturtevant Co., B. F.

Combustion Recorders
* Sarco Engineering Co.

Compressors, Air
Buffalo Fdry. & Mch. Co.
Clayton Air Compressor Works
* Devine Co., J. P.
* General Electric Co.
* Goulds Manufacturing Co.
* Hooven, Owens, Rentschler Co.
* Ingersoll-Rand Co.
* International Steam Pump Co.
Laidlaw-Dunn-Gordon Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
* Otto Gas Engine Works
* Roots Co., P. H. & F. M.
* Southwark Fdry. & Mch. Co.

Compressors, Air, Compound
Clayton Air Compressor Works
* Ingersoll-Rand Co.
* International Steam Pump Co.
Laidlaw-Dunn-Gordon Co.
Mesta Machine Co.

Compressors, Ammonia
* Vilter Mfg. Co.

Compressors, Gas
* Hooven, Owens, Rentschler Co.
* Ingersoll-Rand Co.
Mesta Machine Co.
* Roots Co., P. H. & F. M.
* Southwark Fdry. & Mch. Co.

Condensers
* Blake & Knowles Steam Pump Works
Buffalo Fdry. & Mch. Co.
Davidson Co., M. T.
Deane Steam Pump Co.
* Devine Co., J. P.
* International Steam Pump Co.
Laidlaw-Dunn-Gordon Co.
* Southwark Fdry. & Mch. Co.
Westinghouse Machine Co.
* Worthington, Henry R.

Condensers, Ammonia
* De La Vergne Machine Co.
* Vilter Mfg. Co.

Condensers, Barometric
* Blake & Knowles Steam Pump Works
Buffalo Fdry. & Mch. Co.
Mesta Machine Co.
* Southwark Fdry. & Mch. Co.
* Worthington, Henry R.

Condensers, Jet
* Blake & Knowles Steam Pump Works
Davidson Co., M. T.
General Condenser Co.
* International Steam Pump Co.
Schutte & Koerting Co.
* Southwark Fdry. & Mch. Co.
* Worthington, Henry R.

Condensers, Surface
Buffalo Fdry. & Mch. Co.
Davidson Co., M. T.
General Condenser Co.
* Southwark Fdry. & Mch. Co.
Westinghouse Machine Co.
* Worthington, Henry R.

Conduit
* American Vulcanized Fibre Co.
Johns-Manville Co., H. W.

Contractors
* Wendland Engrg. & Construction Co., C. F.

Controllers, Automatic, for Temperature or for Pressure
(See Regulators)

Controllers, Electric
* General Electric Co.
Morgan Engineering Co.
Westinghouse Elec. & Mfg. Co.

Converters, Steel
Whiting Foundry Equip. Co.

Converters, Synchronous
* General Electric Co.
Westinghouse Elec. & Mfg. Co.

Conveying Machinery
* Caldwell & Son Co., H. W.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Link-Belt Co.
Mathews Gravity Carrier Co.
Webster Mfg. Co.

Conveying Systems, Pneumatic (Light Material)
Sturtevant Co., B. F.

Conveyors, Belt
* Caldwell & Son Co., H. W.
Jeffrey Mfg. Co.
* Link-Belt Co.
Webster Mfg. Co.

Conveyors, Bucket, Pan or Apron
* Caldwell & Son Co., H. W.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Link-Belt Co.
Webster Mfg. Co.

Conveyors, Gravity
Mathews Gravity Carrier Co.

Conveyors, Gravity Roller
Mathews Gravity Carrier Co.

Conveyors, Screw
* Caldwell & Son Co., H. W.
Jeffrey Mfg. Co.
* Link-Belt Co.
Webster Mfg. Co.

Cooling Ponds, Spray
Schutte & Koerting Co.

Cooling Towers
* Worthington, Henry R.

Copper, Drawn
* Roebling's Sons Co., John A.

Copper Wire and Cables
(See Wires and Cables, Electrical)

Copper Converting Machinery
* Alliance Machine Co.

Core Ovens
Whiting Foundry Equip. Co.

Corliss Engines
(See Engines, Corliss)

Counters, Revolution
Ashton Valve Co.
* Veeder Mfg. Co.

Countershafts
Builders Iron Foundry
* Hill Clutch Co.
Wood's Sons Co., T. B.

Counting Machines, Automatic
* Veeder Mfg. Co.

Couplings, Flexible
* Falls Clutch & Machinery Co.
* Hooven, Owens, Rentschler Co.
* Roots Co., P. H. & F. M.

Couplings, Pipe
Central Foundry Co.
* Crane Co.
Lunkenheimer Co.
* Pratt & Cady Co., Inc.
Walworth Mfg. Co.

Couplings, Shaft
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
Cumberland Steel Co.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
Holyoke Machine Co.
* Moore & White Co.
Royersford Foundry & Machine Co.
Webster Mfg. Co.
Wood's Sons Co., T. B.

Couplings, Union
(See Unions)

Couplings, Universal Joint
Wood's Sons Co., T. B.

Coverings, Boiler
Johns-Manville Co., H. W.

Coverings, Pipe
Johns-Manville Co., H. W.

Cranes, Electric Travelling
* Alliance Machine Co.
* Box & Co., Alfred
Manning, Maxwell & Moore, Inc.
Morgan Engineering Co.
Northern Engineering Works
Shaw Electric Crane Co.
Toledo Bridge & Crane Co.
Whiting Foundry Equip. Co.

Cranes, Gantry
* Alliance Machine Co.
* Link-Belt Co.
Manning, Maxwell & Moore, Inc.
Morgan Engineering Co.
Northern Engineering Works
Orton & Steinbrenner Co.
Shaw Electric Crane Co.
Toledo Bridge & Crane Co.
Whiting Foundry Equip. Co.

Cranes, Hand Power
* Box & Co., Alfred
* Clyde Iron Works
Manning, Maxwell & Moore, Inc.
Northern Engineering Works
Shaw Electric Crane Co.
Toledo Bridge & Crane Co.
Whiting Foundry Equip. Co.

Cranes, Hydraulic
* Alliance Machine Co.
Whiting Foundry Equip. Co.
* Wood & Co., R. D.

Cranes, Jib
* Alliance Machine Co.
* Box & Co., Alfred
Manning, Maxwell & Moore, Inc.
Morgan Engineering Co.
Northern Engineering Works
Shaw Electric Crane Co.
Toledo Bridge & Crane Co.
Whiting Foundry Equip. Co.
Wood & Co., R. D.

Cranes, Locomotive
* Link-Belt Co.
Morgan Engineering Co.
Orton & Steinbrenner Co.

Cranes, Pillar
Manning, Maxwell & Moore, Inc.
Northern Engineering Works
Orton & Steinbrenner Co.
Shaw Electric Crane Co.
Toledo Bridge & Crane Co.
Whiting Foundry Equip. Co.

Cranes, Portable
* Clyde Iron Works
* Lidgerwood Mfg. Co.

Cranes, Wharf
Shaw Electric Crane Co.

Crushers, Jaw
Power & Mining Mchy. Co.

Crushers, Powdered Coal
* Quigley Furnace & Fdry. Co.

Crushers, Roll
Eastern Machinery Co.
Jeffrey Mfg. Co.
Orton & Steinbrenner Co.
Power & Mining Mchy. Co.

Crushing and Grinding Machinery
* Fulton Iron Works
Jeffrey Mfg. Co.
Power & Mining Mchy. Co.

Cupolas
Northern Engineering Works
Whiting Foundry Equip. Co.

Cutters, Bolt
Wells Bros. Co.

Cylinders, Rebored
* Wendland Engrg. & Construction Co., C. F.

Damper Regulators
(See Regulators, Damper)

Derricks and Derrick Fittings
* Clyde Iron Works
* Lidgerwood Mfg. Co.

Destructors, Refuse
Power Specialty Co.

Die Castings
(See Castings, Die)

Dies, Screw and Thread Cutting
* Jones & Lamson Machine Co.
Wells Bros. Co.

Dies, Self-opening
* Jones & Lamson Machine Co.
Wells Bros. Co.

Digesters, Pulp
* Hooven, Owens, Rentschler Co.

Discs, Valve
(See Valve Discs)

Distillers
Davidson Co., M. T.

Drainage Systems
Morehead Mfg. Co.

Draft, Mechanical
(See Mechanical Draft Apparatus)

Dredges, Hydraulic
* Morris Machine Works

Drilling Machines, Pneumatic
* Ingersoll-Rand Co.

Drilling Machines, Rock
* Ingersoll-Rand Co.

Drills, Coal and Slate
Jeffrey Mfg. Co.

Drinking-Fountains, Sanitary
Manufacturing Equipment & Engrg. Co.

Drop Forgings, Hammers, Presses, etc.
(See Forgings, Hammers, Presses, etc., Drop)

Dryers, Drum
Buffalo Fdry. & Mch. Co.
* Devine Co., J. P.

Dryers, Powdered Coal
* Quigley Furnace & Fdry. Co.

Dryers, Rotary
Buffalo Fdry. & Mch. Co.
* Devine Co., J. P.
Whiting Foundry Equip. Co.

Dryers, Vacuum
Buffalo Fdry. & Mch. Co.
* Devine Co., J. P.

Drying Apparatus
Buffalo Fdry. & Mch. Co.
* Devine Co., J. P.
Sturtevant Co., B. F.

Dust Arresters (For Tumbling Mills)
Whiting Foundry Equip. Co.

Economizers, Fuel
Sturtevant Co., B. F.

Ejectors
Lunkenheimer Co.
Manning, Maxwell & Moore, Inc.
Schutte & Koerting Co.

Ejectors, Ash, Hydraulic
Davidson Co., M. T.

Ejectors, Ash, Pneumatic
* Green Engineering Co.

Electric Generators, Hoists, Trucks, Welding, etc.
(See Generators, Hoists, Trucks, Welding, etc., Electric)

Electrical Machinery
Crocker-Wheeler Co.
Electro Dynamic Co.
* General Electric Co.
Westinghouse Elec. & Mfg. Co.

Electrical Measuring Instruments
(See Instruments, Electrical Measuring)

Electrical Supplies
* General Electric Co.
Johns-Manville Co., H. W.

Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1915 Volume

Electrical Testing
Electrical Testing Laboratories, Inc.

Elevating and Conveying Machinery
* Caldwell & Son Co., H. W.
* Hill Clutch Co.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Link-Belt Co.
Mathews Gravity Carrier Co.
Webster Mfg. Co.

Elevators, Electric
Eastern Machinery Co.
Northern Engineering Works
Whiting Foundry Equip. Co.

Elevators, Inclined
(See Carriers and Elevators, Freight, Continuous)

Elevators, Passenger and Freight
Eastern Machinery Co.
Northern Engineering Works
Whiting Foundry Equip. Co.

Elevators, Pneumatic
Whiting Foundry Equip. Co.

Emery Wheel Dressers
Builders Iron Foundry

Engine Repairs
* Wendland Engrg. & Construction Co., C. F.

Engine Stops
Schutte & Koerting Co.

Engineers, Consulting
(See Directory of Consulting Engineers)

Engines, Automatic
* Ball Engine Co.
Erie City Iron Works
Harrisburg Foundry & Machine Works
Westinghouse Machine Co.

Engines, Blowing
* Hooven, Owens, Rentschler Co.
Mesta Machine Co.
Mackintosh, Hemphill & Co.
Weimer Machine Works Co.

Engines, Corliss
* Ball Engine Co.
* Fulton Iron Works
Harrisburg Foundry & Machine Works
* Hooven, Owens, Rentschler Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Providence Engineering Works
* Vilter Mfg. Co.

Engines, Gas and Gasoline
* De La Vergne Machine Co.
* Hooven, Owens, Rentschler Co.
International Gas Engine Co.
* International Steam Pump Co.
Mesta Machine Co.
* National Meter Co.
* Otto Gas Engine Works
Snow Steam Pump Works
Sturtevant Co., B. F.
Westinghouse Machine Co.

Engines, High Speed
* Ball Engine Co.
Erie City Iron Works
* Fulton Iron Works
Harrisburg Foundry & Machine Works
Sturtevant Co., B. F.

Engines, Hoisting
(See Hoists, Steam)

Engines, Oil
* De La Vergne Machine Co.
* Fulton Iron Works
* Otto Gas Engine Works
Snow Steam Pump Works
* Southwark Fdry. & Mch. Co.

Engines, Poppet Valve, for Superheated Steam
Erie City Iron Works
Mesta Machine Co.

Engines, Pumping
Davidson Co., M. T.
Holly Mfg. Co.
* Hooven, Owens, Rentschler Co.
* International Steam Pump Co.
* Morris Machine Works
* Otto Gas Engine Works
Snow Steam Pump Works
Wood & Co., R. D.
* Worthington, Henry R.

Engines, Steam
* Ball Engine Co.
* Clyde Iron Works
Erie City Iron Works
* Fulton Iron Works
Harrisburg Foundry & Machine Works
* Hooven, Owens, Rentschler Co.
* Lidgerwood Mfg. Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
* Morris Machine Works
Providence Engineering Works
Sturtevant Co., B. F.
* Vilter Mfg. Co.
Weimer Machine Works Co.
Westinghouse Machine Co.

Engines, Steering
* Lidgerwood Mfg. Co.

Engines, Uniflow
Mesta Machine Co.

Evaporators
Buffalo Fdry. & Mch. Co.
Davidson Co., M. T.

Excavating Machinery
* Clyde Iron Works
* Lidgerwood Mfg. Co.
Orton & Steinbrenner Co.

Exhaust Heads
Sturtevant Co., B. F.

Exhausters, Gas
* Roots Co., P. H. & F. M.
Schutte & Koerting Co.
* Southwark Fdry. & Mch. Co.
Sturtevant Co., B. F.

Expansion Joints
(See Joints, Expansion)

Extracting Apparatus
* Devine Co., J. P.

Extractors, Tar
Smith Gas Power Co.

Factory Equipment, Metal
Manufacturing Equipment & Engrg. Co.

Fans, Electric
* General Electric Co.
Sturtevant Co., B. F.

Fans, Exhaust and Ventilating
Jeffrey Mfg. Co.
Sturtevant Co., B. F.

Feed Water Circulators, Heaters, Heaters and Purifiers, Regulators, etc.
(See Circulators, Heaters, Heaters and Purifiers, Regulators, etc., Feed Water)

Ferrules
* American Vulcanized Fibre Co.

Fibre
* American Vulcanized Fibre Co.

Filters, Air
General Condenser Co.

Filters, Water
* Scaife & Sons Co., Wm. B.

Fire Tube Boilers
(See Boilers, Tubular)

Fire Brick, Hydrants, etc.
(See Brick, Hydrants, etc.)

Fittings, Ammonia
* Crane Co.
* De La Vergne Machine Co.
* Vilter Mfg. Co.
Walworth Mfg. Co.

Fittings, Flanged
Builders Iron Foundry
* Central Foundry Co.
* Crane Co.
Lunkenheimer Co.
Nelson Valve Co.
Walworth Mfg. Co.
Wood & Co., R. D.

Fittings, Hydraulic
* Crane Co.
Walworth Mfg. Co.
Wood & Co., R. D.

Fittings, Pipe
* Central Foundry Co.
* Crane Co.
Lunkenheimer Co.
Walworth Mfg. Co.

Fittings, Steel
* Crane Co.
Lunkenheimer Co.
Nelson Valve Co.
Walworth Mfg. Co.

Flanges
* Crane Co.
Lunkenheimer Co.
Walworth Mfg. Co.

Flanging Machines
Morgan Engineering Co.

Floor Stands
* Crane Co.
Davis Regulator Co., G. M.
Lunkenheimer Co.
Ludlow Valve Mfg. Co.
Nelson Valve Co.
Schutte & Koerting Co.
Walworth Mfg. Co.

Forges
Best, W. N.
* Ingersoll-Rand Co.
* Roots Co., P. H. & F. M.
Sturtevant Co., B. F.

Forging Presses
(See Presses, Forging)

Forgings, Steel
Mesta Machine Co.

Foundry Equipment
Northern Engineering Works
Whiting Foundry Equip. Co.

Friction Clutches, Hoists, etc.
(See Clutches, Hoists, etc., Friction)

Friction Drives
Rockwood Mfg. Co.

Frictions, Fibre
* American Vulcanized Fibre Co.

Frictions, Paper and Iron
* Caldwell & Son Co., H. W.
Rockwood Mfg. Co.
Webster Mfg. Co.

Fuel Economizers
(See Economizers, Fuel)

Furnace Linings
(See Linings, Furnace)

Furnaces, Annealing and Tempering
Best, W. N.
* Quigley Furnace & Fdry. Co.
Whiting Foundry Equip. Co.

Furnaces, Boiler
American Engineering Co.
Babcock & Wilcox Co.
Best, W. N.
Combustion Engineering Corp.
* Green Engineering Co.
* Murphy Iron Works
Riley Stoker Co., Ltd., Sanford

Furnaces, Boiler (Powdered Coal)
* Quigley Furnace & Fdry. Co.

Furnaces, Gas
* Quigley Furnace & Fdry. Co.

Furnaces, Melting
Best, W. N.
* Quigley Furnace & Fdry. Co.
Whiting Foundry Equip. Co.

Furnaces, Oil
* Ingersoll-Rand Co.
Best, W. N.
* Quigley Furnace & Fdry. Co.
Whiting Foundry Equip. Co.

Furnaces, Smokeless
American Engineering Co.
Babcock & Wilcox Co.
Combustion Engineering Corp.
* Green Engineering Co.
* Murphy Iron Works
* Quigley Furnace & Fdry. Co.
Riley Stoker Co., Ltd., Sanford

Fuses
Johns-Manville Co., H. W.

Gage Boards
Ashton Valve Co.
Foxboro Co.

Gage Testers
Ashton Valve Co.

Gages, Ammonia
Ashton Valve Co.
Foxboro Co.

Gages, Ball
* Atlas Ball Co.

Gages, Differential Pressure
Builders Iron Foundry
Foxboro Co.

Gages, Draft
* American Steam Gauge & Valve Mfg. Co.
Ashton Valve Co.
Foxboro Co.
* Taylor Instrument Cos.

Gages, Hydraulic
Ashton Valve Co.
Foxboro Co.

Gages, Pressure
Ashton Valve Co.
Foxboro Co.
* Goulds Manufacturing Co.
Manning, Maxwell & Moore, Inc.

Gages, Surface, Depth, Dial, etc.
* Atlas Ball Co.

Gages, Thread
Wells Bros. Co.

Gages, Vacuum
Ashton Valve Co.
Foxboro Co.
* Taylor Instrument Cos.

Gages, Water
Ashton Valve Co.
* Crane Co.
* Jenkins Bros.
Lunkenheimer Co.
Walworth Mfg. Co.

Gages, Water Level
Foxboro Co.

Gas Burners, Compressors, Engines, Exhausters, Holders, Producers, etc.
(See Burners, Compressors, Engines, Exhausters, Holders, Producers, etc., Gas)

Gas Cleaning Plants
Smith Gas Power Co.
Wood & Co., R. D.

Gas Plant Machinery
Wood & Co., R. D.

Gas Valves
Smith Gas Power Co.

Gaskets
* American Vulcanized Fibre Co.
* Goodrich Co., B. F.
* Jenkins Bros.
Johns-Manville Co., H. W.
Power Specialty Co.

Gasoline
* Texas Co.

Gates, Blast
* Roots Co., P. H. & F. M.
Sturtevant Co., B. F.

Gates, Cut-off
* Hunt Co., Inc., C. W.
* Link-Belt Co.
Webster Mfg. Co.

Gates, Sluice
Ludlow Valve Mfg. Co.
Wood & Co., R. D.

Gear Shapers
* Fellows Gear Shaper Co.

Gears, Cut
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Hill Clutch Co.
Holyoke Machine Co.
James Mfg. Co., D. O.
Jeffrey Mfg. Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
New Process Gear Corp.
Northern Engineering Works
Webster Mfg. Co.

Gears, Fibre
* American Vulcanized Fibre Co.
* General Electric Co.
James Mfg. Co., D. O.
New Process Gear Corp.

Gears, Machine Molded
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Hill Clutch Co.
Mesta Machine Co.

Gears, Rawhide
James Mfg. Co., D. O.
New Process Gear Corp.

Gears, Speed Reduction
James Mfg. Co., D. O.
Westinghouse Machine Co.

Gears, Worm
* Caldwell & Son Co., H. W.
James Mfg. Co., D. O.

Generating Sets
* General Electric Co.
Sturtevant Co., B. F.
Westinghouse Machine Co.

Generators, Electric
Crocker-Wheeler Co.
* General Electric Co.
Westinghouse Elec. & Mfg. Co.

Glass Machinery, Plate
* Hooven, Owens, Rentschler Co.

Governors, Gas Engine
* Pickering Governor Co.

Governors, Pump
Davis Regulator Co., G. M.
* Foster Engineering Co.

Governors, Steam Engine
* Pickering Governor Co.

Governors, Steam Turbine
* Pickering Governor Co.

Governors, Water Wheel
Holyoke Machine Co.

Grates and Grate Bars
Combustion Engineering Corp.

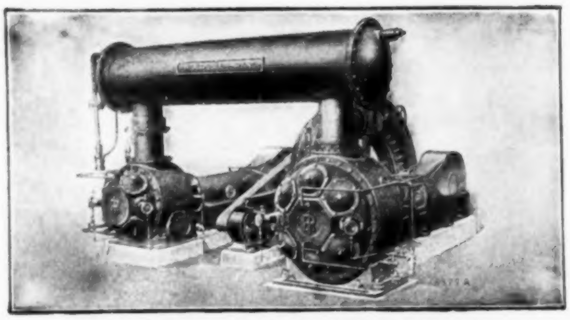
Grates, Dumping
Combustion Engineering Corp.

Grates, Shaking
Combustion Engineering Corp.
Erie City Iron Works
* Springfield Boiler & Mfg. Co.

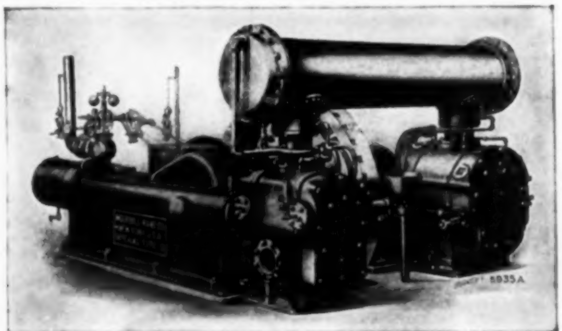
Greases
Royersford Foundry & Machine Co.
* Texas Co.

Grease Cups
(See Oil and Grease Cups)

AIR COMPRESSORS



"Ingersoll-Rogler" Class "PRE" Electrically Driven Air Compressors. Capacities 1278—8345 cu. ft. Bulletin 3024.



"Imperial" Type Ten Steam and Power Driven Air Compressors. Capacities 176—3395 cu. ft. Bulletin 3311.

The Ingersoll-Rand line of air compressors is the largest, most complete and diversified on the market. It comprises a wide range of sizes and all types of drive. Capacities from 3 to 60,000 cubic feet and pressures up to 3000 lbs.—belt driven, steam driven, (Meyer Valve, Balanced Piston Valve and Corliss) electric driven, both direct connected, geared and short belt types, chain and rope drive, gasoline and oil engine drives, and steam turbine driven in centrifugal or turbo types.

It represents every desirable refinement in air compressor design and construction that makes for high economy and efficiency and that will in any way contribute toward durability, ease of operation and independence.

Its mechanical excellence is supported by a worldwide organization and by the experience, reputation and permanence of its builders.

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INGERSOLL-RAND COMPANY

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NEW YORK LONDON

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I. P. MORRIS COMPANY

PHILADELPHIA, PA.

Specialists in the Design and Construction of High Class, High Power, and High Efficiency Hydraulic Turbines

Illustration shows method of placing of the wooden forms for draft tubes for three 9700 horse-power turbines. Head 54 feet, Speed 97.3 revolutions per minute. Designed and built by I. P. Morris Company for Turners Falls Power and Electric Company, Montague City, Massachusetts.

These units are of the single runner, vertical shaft type, with the volute casings and draft tubes formed in the concrete, as indicated in the illustration. Erection of the first three units is about complete, and an order has just been placed with this Company for a fourth unit.

The I. P. Morris Company have built or have under construction turbines of this type aggregating 495,600 horse-power.

Inquiries for turbines requiring special design will be given every attention.

Grease Extractors
(See Separators, Oil)
Grinders
* Brown Co., A. & F.
Grinding or Polishing Machines
Builders Iron Foundry
Heald Machine Co.
Royersford Foundry & Machine Co.
Grinding Machines, Cutter
Heald Machine Co.
Le Blond Machine Tool Co., R. K.
Grinding Machines, Cylindrical
Heald Machine Co.
Grinding Machines, Drill
Heald Machine Co.
Grinding Machines, Internal
Heald Machine Co.
Grinding Machines, Portable, Pneumatic
* Ingersoll-Rand Co.
Grinding Machines, Surface
Heald Machine Co.
Grinding Machines, Tool
Heald Machine Co.
Le Blond Machine Tool Co., R. K.
Gun and Motor Carriages
Morgan Engineering Co.

Hammers, Drop
* Alliance Machine Co.
Hammers, Pneumatic
* Ingersoll-Rand Co.
Hammers, Steam
* Alliance Machine Co.
Buffalo Fdry. & Mch. Co.
Morgan Engineering Co.
Hangers, Shaft
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
Jeffrey Mfg. Co.
Royersford Foundry & Machine Co.
Webster Mfg. Co.
Wood's Sons Co., T. B.
Head Gates
Holyoke Machine Co.
Heaters, Feed Water (Closed)
* Blake & Knowles Steam Pump Works
Erie City Iron Works
National Pipe Bending Co.
Schutte & Koerting Co.
Heaters and Mixers, Water, Instantaneous
Manufacturing Equipment & Engrg. Co.
Heaters and Purifiers, Feed Water (Open)
Erie City Iron Works
National Pipe Bending Co.
* Springfield Boiler & Mfg. Co.
Heating Boilers
(See Boilers, Heating)
Heating and Ventilating Apparatus
* Smith Co., H. B.
Sturtevant Co., B. F.
Hoisting and Conveying Machinery
* Box & Co., Alfred
* Clyde Iron Works
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Lidgerwood Mfg. Co.
* Link-Belt Co.
Northern Engineering Works
Orton & Steinbrenner Co.
Whiting Foundry Equip. Co.
Hoists, Air
* Ingersoll-Rand Co.
Northern Engineering Works
Whiting Foundry Equip. Co.
Hoists, Belt
* Clyde Iron Works
* Lidgerwood Mfg. Co.
Hoists, Electric
* Alliance Machine Co.
* Box & Co., Alfred
* Clyde Iron Works
* General Electric Co.
* Hunt Co., Inc., C. W.
* Lidgerwood Mfg. Co.
* Link-Belt Co.
Northern Engineering Works
Orton & Steinbrenner Co.
Shaw Electric Crane Co.
Whiting Foundry Equip. Co.

Hoists, Friction
Eastern Machinery Co.
Whiting Foundry Equip. Co.
Hoists, Gas and Gasolene
* Otto Gas Engine Works
Hoists, Hand
* Box & Co., Alfred
* Clyde Iron Works
* Link-Belt Co.
Northern Engineering Works
Whiting Foundry Equip. Co.
Hoists, Mine
* Lidgerwood Mfg. Co.
Hoists, Skip
* Hunt Co., Inc., C. W.
* Lidgerwood Mfg. Co.
Hoists, Steam
* Clyde Iron Works
* Hunt Co., Inc., C. W.
* Lidgerwood Mfg. Co.
* Morris Machine Works
Orton & Steinbrenner Co.
Holders, Gas
Wood & Co., R. D.
Hose, Air
* Goodrich Co., B. F.
* Ingersoll-Rand Co.
Hose, Linen
* Goodrich Co., B. F.
Hose, Metallic
Johns-Manville Co., H. W.
Hose, Oil
* Goodrich Co., B. F.
Hose, Rubber
* Goodrich Co., B. F.
Hose, Steam
* Goodrich Co., B. F.
* Ingersoll-Rand Co.
Hose, Suction
* Goodrich Co., B. F.
Hose Attachments (Couplings, Bands, Holders, Clamps, etc.)
* Goodrich Co., B. F.
* Ingersoll-Rand Co.
Hydrants, Fire
Ludlow Valve Mfg. Co.
Wood & Co., R. D.
Hydraulic Jacks, Rams, Presses, Turbines, etc.
(See Jacks, Rams, Presses, Turbines, etc., Hydraulic)
Hydraulic Machinery
* Alliance Machine Co.
Holyoke Machine Co.
Mackintosh, Hemphill & Co.
Morgan Engineering Co.
* Wood & Co., R. D.
Hydrokineters
Schutte & Koerting Co.
Hygrometers
Foxboro Co.
* Taylor Instrument Cos.
Ice and Refrigeration Machinery
* De La Vergne Machine Co.
Johns-Manville Co., H. W.
* Vilter Mfg. Co.
Ice Tools
* Caldwell & Son Co., H. W.
Impregnating Apparatus
Buffalo Fdry. & Mch. Co.
* Devine Co., J. P.
Incandescent Lamps
(See Lamps, Incandescent)
Indicator Posts
* Crane Co.
Ludlow Valve Mfg. Co.
* Pratt & Cady Co., Inc.
Wood & Co., R. D.
Indicators, Engine
Manning, Maxwell & Moore, Inc.
Indicators, Speed
Foxboro Co.
* Veeder Manufacturing Co.
Weston Electrical Instrument Co.
Industrial Railways
(See Railways, Industrial)
Ingot Strippers
* Alliance Machine Co.
Morgan Engineering Co.
Injectors
Manning, Maxwell & Moore, Inc.
Lunkenheimer Co.
Schutte & Koerting Co.
Instruments, Electrical Measuring
* General Electric Co.
* Taylor Instrument Cos.
Westinghouse Elec. & Mfg. Co.
Weston Electric Instrument Co.

Instruments, Physical
* Taylor Instrument Cos.
Instruments, Recording
Ashton Valve Co.
Builders Iron Foundry
Foxboro Co.
* General Electric Co.
* Taylor Instrument Cos.
Westinghouse Elec. & Mfg. Co.
Yarnall-Waring Co.
Instruments, Testing
* Norma Co. of America
Insulating Materials (Elec.)
* American Vulcanized Fibre Co.
Insulating Materials (Heat and Cold)
Johns-Manville Co., H. W.

Jigs and Fixtures
Cowdrey Machine Works, C. H.
Joints, Expansion
* Crane Co.
Lunkenheimer Co.
Power Specialty Co.
Walworth Mfg. Co.
Joints, Flanged Pipe
* Crane Co.
Walworth Mfg. Co.
Jolt Ramming Machines
(See Rammers, Foundry)

Kettles
Buffalo Fdry. & Mch. Co.
Kettles, Soda
Manufacturing Equipment & Engrg. Co.
Kilns, Dry
Sturtevant Co., B. F.

Ladles
Northern Engineering Works
Whiting Foundry Equip. Co.
Lamps, Incandescent
* General Electric Co.
Johns-Manville Co., H. W.
Westinghouse Elec. & Mfg. Co.
Land-Clearing Machinery
* Clyde Iron Works
Lathe Attachments
Le Blond Machine Tool Co., R. K.
Lathes
Builders Iron Foundry
* Jones & Lamson Machine Co.
Le Blond Machine Tool Co.
Manning, Maxwell & Moore, Inc.
* Warner & Swasey Co.
Lathes, Automatic
* Jones & Lamson Machine Co.
Lathes, Brass
* Warner & Swasey Co.
Lathes, Chucking
* Jones & Lamson Machine Co.
Lathes, Speed
Le Blond Machine Tool Co.
Lathes, Turret
* Jones & Lamson Machine Co.
* Warner & Swasey Co.
Lathes, Turret, Vertical
King Machine Tool Co.
Leather Belting, Packing, etc.
(See Belting, Packing, etc., Leather)
Leathers, Automobile
Schieren Co., Chas. A.
Leathers, Pump
Schieren Co., Chas. A.
Lightning Arresters
* General Electric Co.
Lining, Brake
Johns-Manville Co., H. W.
Lining, Furnace
Best, W. N.
Johns-Manville Co., H. W.
Lining, Stack
Johns-Manville Co., H. W.
Liquid Fuel Equipment
Best, W. N.
Loaders, Wagon
Jeffrey Mfg. Co.
* Link-Belt Co.
Lockers, Metal
Manufacturing Equipment & Engrg. Co.
Locomotives, Compressed Air
* Ingersoll-Rand Co.
Locomotives, Electric
* General Electric Co.
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
Westinghouse Elec. & Mfg. Co.

Logging Machinery
* Clyde Iron Works
* Lidgerwood Mfg. Co.
Lubricants
Royersford Foundry & Machine Co.
* Texas Co.
Lubricators, Cylinder
Crescent Mfg. Co.
Lunkenheimer Co.
Lubricators, Force-Feed
Lunkenheimer Co.
* Pickering Governor Co.
Lubricators, Hydrostatic
Crescent Mfg. Co.
Lunkenheimer Co.

Machinery
(Is classified under the headings descriptive of character thereof)
Machinery Dealers
Manning, Maxwell & Moore, Inc.
Machinists and Engineers
* Brown Co., A. & F.
Builders Iron Foundry
* Caldwell & Son Co., H. W.
Cowdrey Machine Works, C. H.
* Hill Clutch Co.
* Lammert & Mann
Mesta Machine Co.
Webster Mfg. Co.
Weimer Machine Works Co.
* Wendland Engrg. & Construction Co., C. F.
Wood & Co., R. D.
Mechanical Draft Apparatus
Sturtevant Co., B. F.
Mechanical Stokers
(See Stokers)
Metal Equipment
Manufacturing Equipment & Engrg. Co.
Metal Work, Plate
Heine Safety Boiler Co.
* Keeler Co., E.
* Wood & Co., R. D.
Meters, Air and Gas
Builders Iron Foundry
* General Electric Co.
Meters, Electric
* General Electric Co.
Westinghouse Elec. & Mfg. Co.
Meters, Feed Water
Builders Iron Foundry
Yarnall-Waring Co.
Meters, Steam
Builders Iron Foundry
* General Electric Co.
Meters, V-Notch
Yarnall-Waring Co.
Meters, Venturi
Builders Iron Foundry
* National Meter Co.
Meters, Water
* National Meter Co.
* Worthington, Henry R.
Micrometers
Wells Bros. Co.
Milling Attachments
Le Blond Machine Tool Co., R. K.
Milling Machines, Plain
Le Blond Machine Tool Co., R. K.
* Warner & Swasey Co.
Milling Machines, Universal
Le Blond Machine Tool Co., R. K.
Mills, Blooming and Slabbing
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Mills, Cinder, Water
Whiting Foundry Equip. Co.
Mills, Sheet and Plate
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Mills, Structural, Rail and Bar
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Mills, Sugar Cane
* Fulton Iron Works
Mesta Machine Co.
Monorail Systems
(See Tramrail Systems, Overhead)
Motor-Generators
Crocker-Wheeler Co.
* General Electric Co.
Westinghouse Elec. & Mfg. Co.
Motors, Compressed Air
* Ingersoll-Rand Co.

Motors, Electric
Crocker-Wheeler Co.
Electro Dynamic Co.
* General Electric Co.
Westinghouse Elec. & Mfg. Co.

Nozzles, Blast
Schutte & Koerting Co.
Nozzles, Sand and Air
* Ingersoll-Rand Co.
Lunkenheimer Co.
Nozzles, Spray
Schutte & Koerting Co.

Odometers
* Veeder Manufacturing Co.
Oil and Grease Cups
* Crane Co.
Crescent Mfg. Co.
Lunkenheimer Co.
Oil Burners, Engines, Filters, Pumps, Separators, etc.
(See Burners, Engines, Filters, Pumps, Separators, etc., Oil)
Oil Burning Systems
Best, W. N.
* Quigley Furnace & Fdry. Co.
Schutte & Koerting Co.

Oilers, Sight Feed
Lunkenheimer Co.
Oiling Devices
Lunkenheimer Co.
Oiling Systems
Lunkenheimer Co.
Oils, Fuel
* Texas Co.
Oils, Lubricating
* Texas Co.
Ore Handling Machinery
* Hunt Co., Inc., C. W.
Jeffrey Mfg. Co.
* Link-Belt Co.
Toledo Bridge & Crane Co.

Packing, Asbestos
Johns-Manville Co., H. W.
Packing, Hydraulic
* Goodrich, B. F.
Johns-Manville Co., H. W.
Power Specialty Co.
Schieren Co., Chas. A.
Packing, Leather
Schieren Co., Chas. A.
Packing, Metallic
Power Specialty Co.
Packing, Rod (Piston and Valve)
* Goodrich, B. F.
* Jenkins Bros.
Johns-Manville Co., H. W.
Power Specialty Co.
Packing, Rubber
* Goodrich Co., B. F.
* Jenkins Bros.
Packing, Sheet
* American Vulcanized Fibre Co.
* Goodrich Co., B. F.
* Jenkins Bros.
Johns-Manville Co., H. W.
Paint, Metal
Johns-Manville Co., H. W.
Pans, Vacuum
Buffalo Fdry. & Mch. Co.
* Devine Co., J. P.
Paper Machinery
Holyoke Machine Co.
* Moore & White Co.
Pasteurizers
* Vilter Mfg. Co.
Petroleum Products
* Texas Co.
Pickling Machines
Mesta Machine Co.
Pile Drivers
* Clyde Iron Works
* Lidgerwood Mfg. Co.
Pile Drivers, Sheet
* Ingersoll-Rand Co.
Pinions, Rolling Mill
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Pinions, Rawhide
New Process Gear Corp.
Pipe, Cast Iron
Builders Iron Foundry
* Central Foundry Co.
Pipe, Riveted Steel
* Keeler Co., E.
* Springfield Boiler & Mfg. Co.
Pipe, Soil
* Central Foundry Co.
Pipe, Steel
* Crane Co.
Walworth Mfg. Co.

Pipe, Wrought Iron
* Crane Co.
Walworth Mfg. Co.
Pipe Bends and Pipe Bending
* Crane Co.
National Pipe Bending Co.
Walworth Mfg. Co.
Pipe Coils, Covering, Cutters, Fittings, Joints, etc.
(See Coils, Covering, Cutters, Fittings, Joints, etc., Pipe)
Pipe Cutting and Threading Machines
* Crane Co.
Wells Bros. Co.
Pipe Joint Clamps
(See Clamps, Pipe Joint)
Planers, Metal
Manning, Maxwell & Moore, Inc
Plate Metal Work
(See Metal Work, Plate)
Pneumatic Pumping Systems
(See Air Lift Pumping Systems)
Pneumatic Tools
* Ingersoll-Rand Co.
Polishing Machinery
Builders Iron Foundry
Royersford Foundry & Machine Co.
Poppet Valve Engines
(See Engines, Poppet Valve)
Pots, Caustic
Buffalo Fdry. & Mch. Co.
Powdered Coal Equipment (for Boiler & Metallurgical Furnaces)
* Quigley Furnace & Fdry. Co.
Power Transmission Machinery
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
Eastern Machinery Co.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
Holyoke Machine Co.
Jeffrey Mfg. Co.
* Link-Belt Co.
Mesta Machine Co.
* Moore & White Co.
Royersford Foundry & Machine Co.
Webster Mfg. Co.
Wood's Sons Co., T. B.
Presses, Foot
Royersford Foundry & Machine Co.
Presses, Forging (Steam-Hydraulic)
Mesta Machine Co.
* Southwark Fdry. & Mch. Co.
Wood & Co., R. D.
Presses, Hydraulic
* Alliance Machine Co.
* Falls Clutch & Machinery Co.
Holyoke Machine Co.
Manning, Maxwell & Moore, Inc.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
* Southwark Fdry. & Mch. Co.
Wood & Co., R. D.
Presses, Punching and Trimming
Royersford Foundry & Machine Co.
Pressure Regulators
(See Regulators, Pressure)
Producers, Gas
* De La Vergne Machine Co.
* Otto Gas Engine Works
Power & Mining Mch. Co.
Smith Gas Power Co.
Westinghouse Machine Co.
Wood & Co., R. D.
Propellers
* Morris Machine Co.
Pulleys, Iron
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
Holyoke Machine Co.
Jeffrey Mfg. Co.
Webster Mfg. Co.
Wood's Sons Co., T. B.
Pulleys, Paper
Rockwood Mfg. Co.
Pulleys, Steel
* Caldwell & Son Co., H. W.
Pulleys, Wood
* Caldwell & Son Co., H. W.
Pulverizers
* Brown Co., A. & F.
Jeffrey Mfg. Co.

Pulverizers, Powdered Coal
* Quigley Furnace & Fdry. Co.
Pump Governors, Valves, etc.
(See Governors, Valves, etc., Pump)
Pumping Engines
(See Engines, Pumping)
Pumping Machinery
* Blake & Knowles Steam Pump Works
Davidson Co., M. T.
* Goulds Manufacturing Co.
Holly Mfg. Co.
* International Steam Pump Co.
* Morris Co., I. P.
* Morris Machine Works
Providence Engineering Works
Snow Steam Pump Works
* Southwark Fdry. & Mch. Co.
Wood & Co., R. D.
* Worthington, Henry R.
Pumps, Air
* Blake & Knowles Steam Pump Works
Davidson Co., M. T.
General Condenser Co.
* Goulds Manufacturing Co.
* International Steam Pump Co.
Laidlaw-Dunn-Gordon Co.
Mesta Machine Co.
* Roots Co., P. H. & F. M.
Westinghouse Machine Co.
Pumps, Ammonia
* Blake & Knowles Steam Pump Works
Davidson Co., M. T.
Laidlaw-Dunn-Gordon Co.
Pumps, Boiler Feed
* Blake & Knowles Steam Pump Works
Davidson Co., M. T.
Deane Steam Pump Co.
* Goulds Manufacturing Co.
Providence Engineering Works
* Southwark Fdry. & Mch. Co.
* Worthington, Henry R.
Pumps, Centrifugal
* Goulds Manufacturing Co.
Jeanesville Iron Works Co.
* Lammert & Mann
* Morris Co., I. P.
* Morris Machine Works
Providence Engineering Works
* Southwark Fdry. & Mch. Co.
Westinghouse Machine Co.
Wood & Co., R. D.
* Worthington, Henry R.
Pumps, Condensation, with Automatic Receivers
* Blake & Knowles Steam Pump Works
Davidson Co., M. T.
* International Steam Pump Co.
* Worthington, Henry R.
Pumps, Deep Well
Davidson Co., M. T.
Deane Steam Pump Co.
* Goulds Manufacturing Co.
* Ingersoll-Rand Co.
* International Steam Pump Co.
* Morris Machine Works
Pumps, Dredging
* Morris Machine Works
Wood & Co., R. D.
Pumps, Dry Vacuum
(See Pumps, Vacuum)
Pumps, Electric
Deane Steam Pump Co.
* Goulds Manufacturing Co.
* Morris Machine Works
Prescott Steam Pump Co.
Wood & Co., R. D.
* Worthington, Henry R.
Pumps, Hand
* Goulds Manufacturing Co.
Pumps, Hydraulic Pressure
* Blake & Knowles Steam Pump Works
Davidson Co., M. T.
* Goulds Manufacturing Co.
* Morris Machine Works
Wood & Co., R. D.
* Worthington, Henry R.
Pumps, Oil
* Blake & Knowles Steam Pump Works
* Goulds Manufacturing Co.
* International Steam Pump Co.
Lunkenheimer Co.
* Roots Co., P. H. & F. M.
Wood & Co., R. D.
* Worthington, Henry R.
Pumps, Oil, Force-Feed
Lunkenheimer Co.
* Pickering Governor Co.

Pumps, Power
Davidson Co., M. T.
Deane Steam Pump Co.
* Goulds Manufacturing Co.
Holyoke Machine Co.
* International Steam Pump Co.
Wood & Co., R. D.
Pumps, Rotary
* Goulds Manufacturing Co.
Holyoke Machine Co.
* Lammert & Mann
* Roots Co., P. H. & F. M.
Pumps, Steam
* Blake & Knowles Steam Pump Works
Davidson Co., M. T.
* International Steam Pump Co.
Prescott Steam Pump Co.
* Worthington, Henry R.
Pumps, Sump
* Goulds Manufacturing Co.
* Morris Machine Works
Wood & Co., R. D.
Pumps, Tank
* Blake & Knowles Steam Pump Works
Davidson Co., M. T.
Deane Steam Pump Co.
* Goulds Manufacturing Co.
Wood & Co., R. D.
* Worthington, Henry R.
Pumps, Turbine
* General Electric Co.
Jeanesville Iron Works Co.
* Morris Machine Works
* Southwark Fdry. & Mch. Co.
Westinghouse Machine Co.
Wood & Co., R. D.
* Worthington, Henry R.
Pumps, Vacuum
* Blake & Knowles Steam Pump Works
Buffalo Fdry. & Mch. Co.
Davidson Co., M. T.
Deane Steam Pump Co.
* Devine Co., J. P.
General Condenser Co.
* Goulds Manufacturing Co.
* International Steam Pump Co.
* Lammert & Mann
Mesta Machine Co.
* Roots Co., P. H. & F. M.
* Worthington, Henry R.
Punches, Hydraulic
* Alliance Machine Co.
Morgan Engineering Co.
Wood & Co., R. D.
Punches, Power
Royersford Foundry & Machine Co.
Punches, Multiple
Mackintosh, Hemphill & Co.
Wood & Co., R. D.
Punches and Dies
Royersford Foundry & Machine Co.
Punching and Shearing Machines
* Alliance Machine Co.
Morgan Engineering Co.
Royersford Foundry & Machine Co.
Wood & Co., R. D.
Purifying and Softening Systems, Water
* Scaife & Sons Co., Wm. B.
Purifying Machinery, Water (Electrical)
Electric Water Sterilizer Co.
Pyrometers, Electric
Foxboro Co.
* Taylor Instrument Cos.
Pyrometers, Radiation
* Taylor Instrument Cos.

Quarry Machinery
* Ingersoll-Rand Co.

Racks, Cut
James Mfg. Co., D. O.
Racks, Storage, Metal
Manufacturing Equipment & Engrg. Co.
Radiators, Indirect
* Smith Co., H. B.
Radiators, Steam
* Smith Co., H. B.
Walworth Mfg. Co.
Railways, Cable and Automatic
* Hunt Co., Inc., C. W.
Railways, Industrial
* Hunt Co., Inc., C. W.
* Link-Belt Co.
Whiting Foundry Equip. Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1915 Volume*

Rammers, Foundry
* Ingersoll-Rand Co.

Rams, Hydraulic
* Goulds Manufacturing Co.
* Worthington, Henry R.

Reamers
Wells Bros. Co.

Receivers, Air
* Devine Co., J. P.
* Ingersoll-Rand Co.
* International Steam Pump Co.
Laidlaw-Dunn-Gordon Co.
* Scaife & Sons Co., Wm. B.

Recording Instruments
(See Instruments, Recording)

Refrigerating Machinery
* De La Vergne Machine Co.
Johns-Manville Co., H. W.
* Vilter Mfg. Co.
Westinghouse Machine Co.

Refuse Destructors
(See Destructors, Refuse)

Regulators, Blower
Davis Regulator Co., G. M.
* Foster Engineering Co.

Regulators, Damper
Davis Regulator Co., G. M.

Regulators, Electric
* General Electric Co.
Westinghouse Elec. & Mfg. Co.

Regulators, Feed Water
* Almy Water Tube Boiler Co.

Regulators, Flow (Steam)
Davis Regulator Co., G. M.
Schutte & Koerting Co.

Regulators, Pressure
Davis Regulator Co., G. M.
* Foster Engineering Co.
* Golden-Anderson Valve Specialty Co.
* Taylor Instrument Cos.

Regulators, Pump
(See Governors, Pump)

Regulators, Temperature
Foxboro Co.
* Sarco Engineering Co.
* Taylor Instrument Cos.

Regulators, Time
Foxboro Co.

Repairs, Emergency
* Wendland Engrg. & Construction Co., C. F.

Retorts, Acid
Buffalo Fdry. & Mch. Co.

Revolution Counters
(See Counters, Revolution)

Riveters, Hydraulic
* Alliance Machine Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
Wood & Co., R. D.

Riveters, Pneumatic
* Ingersoll-Rand Co.

Roller Bearings
(See Bearings, Roller)

Rolling Mill Machinery
* Alliance Machine Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.

Rolls, Crushing
Power & Mining Mchy. Co.

Rolls, Forging
Mesta Machine Co.

Rolls, Sand, Chilled and Steel
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Power & Mining Mchy. Co.

Rolls, Rubber
* Goodrich Co., B. F.

Roofing
* Texas Co.

Roofing, Asbestos
Johns-Manville Co., H. W.

Rope Drives
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
Jeffrey Mfg. Co.
Webster Mfg. Co.
Wood's Sons Co., T. B.

Rope, Hoisting
* Clyde Iron Works
* Hunt Co., Inc., C. W.
* Roebling's Sons Co., John A.

Rope, Transmission
* Caldwell & Son Co., H. W.
* Hunt Co., Inc., C. W.
* Roebling's Sons Co., John A.

Rope, Wire
* Clyde Iron Works
* Roebling's Sons Co., John A.

Rubber Goods, Mechanical
* Goodrich Co., B. F.
* Jenkins Bros.

Sand Blast Apparatus
* De La Vergne Machine Co.
* Ingersoll-Rand Co.
Lunkenheimer Co.

Screens, Revolving
* Caldwell & Son Co., H. W.
Jeffrey Mfg. Co.
* Link-Belt Co.
Webster Mfg. Co.

Screens, Shaking
* Caldwell & Son Co., H. W.
Jeffrey Mfg. Co.
* Link-Belt Co.

Screw Cutting Dies
(See Dies, Screw and Thread Cutting)

Screw Machines, Hand
* Jones & Lamson Mach. Co
* Warner & Swasey Co.

Screw Plates
Wells Bros. Co.

Screw Steel
* Union Drawn Steel Co.

Separators, Air
General Condenser Co.

Separators, Ammonia
* De La Vergne Machine Co.

Separators, Dust
Sturtevant Co., B. F.

Separators, Oil
Andrews, Inc., William
* Crane Co.
* De La Vergne Machine Co.
General Condenser Co.
National Pipe Bending Co.

Separators, Steam
* Crane Co.
General Condenser Co.
National Pipe Bending Co.

Shafting
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
Cumberland Steel Co.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
Holyoke Machine Co.
* Union Drawn Steel Co.
Wood's Sons Co., T. B.

Shapes, Cold Drawn Steel
* Union Drawn Steel Co.

Shears, Alligator
Mesta Machine Co.
Morgan Engineering Co.

Shears, Hydraulic
* Alliance Machine Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
Wood & Co., R. D.

Shears, Plate
* Alliance Machine Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
Wood & Co., R. D.

Sheaves, Rope
* Brown Co., A. & F.
* Caldwell & Son Co., H. W.
* Clyde Iron Works
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
Jeffrey Mfg. Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Webster Mfg. Co.
Wood's Sons Co., T. B.

Sheet Mill Machinery
Mesta Machine Co.

Shelving, Metal
Manufacturing Equipment & Engrg. Co.

Shipbuilding Machinery
Morgan Engineering Co.

Shredders
Jeffrey Mfg. Co.

Sirens
(See Whistles, Steam)

Sluice Gates
(See Gates, Sluice)

Smoke Recorders
* Sarco Engineering Co.

Smoke Stacks and Flues
(See Stacks, Steel)

Sockets, Wire Rope
(See Wire Rope Fastenings)

Soot Blowing Systems
* Diamond Power Specialty Co.
Vulcan Soot Cleaner Co.

Special Machinery
* Brown Co., A. & F.
Builders Iron Foundry
Cowdrey Machine Works, C. H.
Holyoke Machine Co.
* Lammert & Mann
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
* Morris Co., I. P.
Providence Engineering Works
* Vilter Mfg. Co.
Wood & Co., R. D.

Speed Transmissions, Variable
* Moore & White Co.

Speed Reducing Transmissions
James Mfg. Co., D. O.

Spirals, Gravity Roller
Mathews Gravity Carrier Co.

Spouts, Grain
* Caldwell & Son Co., H. W.
Webster Mfg. Co.

Spray Nozzles
(See Nozzles, Spray)

Sprockets
* Caldwell & Son Co., H. W.
* Hill Clutch Co.
* Link-Belt Co.
Webster Mfg. Co.

Stacks, Steel
Heine Safety Boiler Co.
* Keeler Co., E.

Steam Engines, Separators, Shovels, Superheaters, Traps, Turbines, etc.
(See Engines, Separators, Shovels, Superheaters, Traps, Turbines, etc., Steam)

Steam Specialties
* Crane Co.
Davis Regulator Co., G. M.
* Foster Engineering Co.
* Golden-Anderson Valve Specialty Co.
Lunkenheimer Co.
Manning, Maxwell & Moore, Inc.
Morehead Mfg. Co.
* Sarco Engineering Co.

Steel, Bright Finished
* Union Drawn Steel Co.

Steel, Cold Drawn
* Union Drawn Steel Co.

Steel, Cold Rolled
Cumberland Steel Co.
* Union Drawn Steel Co.

Steel, Nickel
* Union Drawn Steel Co.

Steel, Open Hearth
* Union Drawn Steel Co.

Steel, Vanadium
* Union Drawn Steel Co.

Steering Engines
(See Engines, Steering)

Sterilizers, Water, Electric
Electric Water Sterilizer Co.

Steel Plate Construction
Heine Safety Boiler Co.
* Keeler Co., E.
Wood & Co., R. D.

Stocks and Dies
Wells Bros. Co.

Stokers
American Engineering Co.
Babcock & Wilcox Co.
Combustion Engineering Corp.
* Green Engineering Co.
* Murphy Iron Works
* Quigley Furnace & Fdry. Co.
Riley Stoker Co., Ltd., Sanford
Sturtevant Co., B. F.
Westinghouse Machine Co.

Stokers, Chain Grate
Babcock & Wilcox Co.
Combustion Engineering Corp.
* Green Engineering Co.
Westinghouse Machine Co.

Stokers, Inclined Grate
* Murphy Iron Works
Westinghouse Machine Co.

Stokers, Underfeed
American Engineering Co.
Combustion Engineering Corp.
Riley Stoker Co., Ltd., Sanford
Sturtevant Co., B. F.
Westinghouse Machine Co.

Stools and Chairs, Metal
Manufacturing Equipment & Engrg. Co.

Strainers, Water
Davidson Co., M. T.
* Golden-Anderson Valve Specialty Co.
Schutte & Koerting Co.

Structural Steel Work
Toledo Bridge & Crane Co.

Sugar Machinery
* Hooven, Owens, Rentschler Co.
Wood & Co., R. D.

Superheaters, Air
Power Specialty Co.

Superheaters, Steam
Babcock & Wilcox Co.
Heine Safety Boiler Co.
Power Specialty Co.

Switchboards
* General Electric Co.
Westinghouse Elec. & Mfg. Co.

Switches, Electric
* General Electric Co.
Westinghouse Elec. & Mfg. Co.

Synchronous Converters
(See Converters, Synchronous)

Syphons (Steam-Jet)
Schutte & Koerting Co.

Tachometers
Foxboro Co.
* Veeder Mf. Co.
Weston Electrical Instrument Co.

Tackle Blocks
(See Blocks, Tackle)

Tank Work (Air, Gas, Oil and Water)
Heine Safety Boiler Co.
* Keeler Co., E.
* Scaife & Sons Co., Wm. B.
Wood & Co., R. D.

Tanks, Copper
* Scaife & Sons Co., Wm. B.

Tanks, Storage
* Scaife & Sons Co., Wm. B.

Tanks, Welded
* Scaife & Sons Co., Wm. B.

Taps and Dies
Wells Bros. Co.

Temperature Regulators
(See Regulators, Temperature)

Testing Laboratories, Electrical
Electrical Testing Laboratories, Inc.

Thermometers
Ashton Valve Co.
Foxboro Co.
* Taylor Instrument Cos.

Thermometers, Distance
* Taylor Instrument Cos.

Thread Cutting Tools
* Jones & Lamson Machine Co.
Wells Bros Co.

Time Controllers
(See Regulators, Time)

Time Recorders
Foxboro Co.

Tipples, Steel
Jeffrey Mfg. Co
* Link-Belt Co.
Webster Mfg. Co.

Tools, Brass-Working Machine
* Warner & Swasey Co.

Tools, Machinist's Small
* Atlas Ball Co.

Tools, Pipe Fitters
Walworth Mfg. Co.

Torches, Hand
Best, W. N.

Track, Industrial
* Hunt Co., Inc., C. W.
Northern Engineering Works
Whiting Foundry Equip. Co.

Tramrail Systems, Overhead
* Box & Co., Alfred
* Link-Belt Co.
Manning, Maxwell & Moore, Inc.
Northern Engineering Works
Shaw Electric Crane Co.
Whiting Foundry Equip. Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1915 Volume.*

Tramways, Bridge
* Hunt Co., Inc., C. W.
* Link-Belt Co.
Toledo Bridge & Crane Co.

Tramways, Wire Rope
* Clyde Iron Works
* Roebling's Sons Co., John A.
* Lidgerwood Mfg. Co.

Transfer Tables
Shaw Electric Crane Co.
Whiting Foundry Equip. Co.

Transformers, Electric
Crocker-Wheeler Co.
* General Electric Co.
Westinghouse Elec. & Mfg. Co.

Transmission Machinery
(See Power Transmission Machinery)

Traps, Condenser
Morehead Mfg. Co.

Traps, Return
* Crane Co.
General Condenser Co.
Morehead Mfg. Co.
* Pratt & Cady Co., Inc.

Traps, Steam
* Crane Co.
Davis Regulator Co., G. M.
General Condenser Co.
* Golden-Anderson Valve Specialty Co.
* Jenkins Bros.
Morehead Mfg. Co.
* Sarco Engineering Co.
Schutte & Koerting Co.
Sturtevant Co., B. F.

Traps, Vacuum
* Crane Co.
General Condenser Co.
Morehead Mfg. Co.
* Sarco Engineering Co.

Trolleys, Mono-Rail
(See Tramrail Systems, Overhead)

Trucks, Electric
* Hunt Co., Inc., C. W.

Trucks, Mill
* American Vulcanized Fibre Co.

Tube Cleaners, Boiler
Johns-Manville Co., H. W.

Tubes, Boiler
Parkesburg Iron Co.

Tubes, Charcoal Iron
Parkesburg Iron Co.

Tubing, Fibre
* American Vulcanized Fibre Co.

Tubing, Rubber
* Goodrich Co., B. F.

Tumbling Barrels
Northern Engineering Works
Royersford Foundry & Machine Co.
Whiting Foundry Equip. Co.

Turbines, Hydraulic
Holyoke Machine Co.
* Morris Co., I. P.

Turbines, Steam
* General Electric Co.
* Southwark Fdry. & Mch. Co.
Sturtevant Co., B. F.
Westinghouse Machine Co.

Turbo-Generators
* General Electric Co.
* Southwark Fdry. & Mch. Co.
Sturtevant Co., B. F.
Westinghouse Elec. Mfg. Co.

Turntables
* Hunt Co., Inc., C. W.
Northern Engineering Works
Whiting Foundry Equip. Co.

Turret Machines
* Jones & Lamson Machine Co.
Le Blond Machine Tool Co., R. K.
* Warner & Swasey Co.

Turret Machines, Vertical
King Machine Tool Co.

Unions
* Crane Co.
Lunkenheimer Co.
Walworth Mfg. Co.

Uniflow Engines
(See Engines, Uniflow)

Underfeed Stokers
(See Stokers, Underfeed)

Unloaders, Air Compressor
Yarnall-Waring Co.

Unloaders, Ballast
* Lidgerwood Mfg. Co.

Vacuum Dryers, Pans, Pumps, Traps, etc.
(See Pans, Pumps, Traps, etc., Vacuum)

Vacuum Drying Apparatus
Buffalo Fdry. & Mch. Co.
* Devine Co., J. P.

Valve Balls
* Goodrich Co., B. F.

Valve Boxes
Ludlow Valve Mfg. Co.
Wood & Co., R. D.

Valve Discs
* American Vulcanized Fibre Co.
* Goodrich Co., B. F.
* Jenkins Bros.

Valves, Air, Automatic
Davis Regulator Co., G. M.
* Jenkins Bros.
* Smith Co., H. B.

Valves, Air Relief
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
Schutte & Koerting Co.

Valves, Altitude
* Golden-Anderson Valve Specialty Co.

Valves, Ammonia
* Crane Co.
* De La Vergne Machine Co.
* Jenkins Bros.
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
* Vilter Mfg. Co.
Walworth Mfg. Co.

Valves, Back Pressure
* Crane Co.
Davis Regulator Co., G. M.
* Foster Engineering Co.
* Jenkins Bros.
Nelson Valve Co.
Schutte & Koerting Co.
Walworth Mfg. Co.

Valves, Balanced
* Crane Co.
Davidson Co., M. T.
Davis Regulator Co., G. M.
* Foster Engineering Co.
* Golden-Anderson Valve Specialty Co.
* Homestead Valve Mfg. Co.
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
Schutte & Koerting Co.
Walworth Mfg. Co.

Valves, Blowoff
Ashton Valve Co.
* Crane Co.
* Golden-Anderson Valve Specialty Co.
* Homestead Valve Mfg. Co.
* Jenkins Bros.
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
Walworth Mfg. Co.
Yarnall-Waring Co.

Valves, Butterfly
* Crane Co.
Lunkenheimer Co.
Schutte & Koerting Co.

Valves, Check
* Crane Co.
* Golden-Anderson Valve Specialty Co.
* Jenkins Bros.
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
Nelson Valve Co.
Schutte & Koerting Co.
Walworth Mfg. Co.
Wood & Co., R. D.

Valves, Exhaust Relief
* Crane Co.
Davidson Co., M. T.
Davis Regulator Co., G. M.
* Foster Engineering Co.
* Jenkins Bros.
Schutte & Koerting Co.
Walworth Mfg. Co.

Valves, Float
* Crane Co.
Davis Regulator Co., G. M.
* Foster Engineering Co.
* Golden-Anderson Valve Specialty Co.
* Homestead Valve Mfg. Co.
Ludlow Valve Mfg. Co.
Schutte & Koerting Co.

Valves, Foot
* Crane Co.
Ludlow Valve Mfg. Co.
Walworth Mfg. Co.
Wood & Co., R. D.

Valves, Gate
* Crane Co.
* Jenkins Bros.
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
Nelson Calve Co.
Schutte & Koerting Co.
Walworth Mfg. Co.
Wood & Co., R. D.

Valves, Globe, Angle and Cross
* Crane Co.
* Golden-Anderson Valve Specialty Co.
* Jenkins Bros.
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
Manning, Maxwell & Moore, Inc.
Nelson Valve Co.
Walworth Mfg. Co.

Valves, Hose
* Crane Co.
* Jenkins Bros.
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
Nelson Valve Co.
Walworth Mfg. Co.

Valves, Hydraulic
* Crane Co.
Davidson Co., M. T.
Lunkenheimer Co.
Morgan Engineering Co.
Nelson Valve Co.
Schutte & Koerting Co.
Walworth Mfg. Co.
Wood & Co., R. D.
Yarnall-Waring Co.

Valves, Hydraulic Operating
Lunkenheimer Co.
Schutte & Koerting Co.
Wood & Co., R. D.

Valves, Non-Return
* Crane Co.
Davis Regulator Co., G. M.
* Foster Engineering Co.
* Golden-Anderson Valve Specialty Co.
* Jenkins Bros.
Lunkenheimer Co.
Nelson Valve Co.
Schutte & Koerting Co.
Walworth Mfg. Co.

Valves, Plate, for Blowing Engines
Mesta Machine Co.

Valves, Plug
* Golden-Anderson Valve Specialty Co.
* Homestead Valve Mfg. Co.

Valves, Pop Safety
Ashton Valve Co.
* Crane Co.
Lunkenheimer Co.
Manning, Maxwell & Moore, Inc.

Valves, Pump
* American Vulcanized Fibre Co.
* Goodrich Co., B. F.
* Goulds Manufacturing Co.
* Jenkins Bros.
Johns-Manville Co., H. W.

Valves, Radiator
* Crane Co.
* Jenkins Bros.
Lunkenheimer Co.
Walworth Mfg. Co.

Valves, Reducing
Davis Regulator Co., G. M.
* Foster Engineering Co.
* Golden-Anderson Valve Specialty Co.

Valves, Regulating
* Crane Co.
Davis Regulator Co., G. M.
* Foster Engineering Co.
* Golden-Anderson Valve Specialty Co.
Lunkenheimer Co.

Valves, Relief (Water)
Ashton Valve Co.
* Crane Co.
* Foster Engineering Co.
* Golden-Anderson Valve Specialty Co.
Ludlow Valve Co.
Lunkenheimer Co.
Wood & Co., R. D.

Valves, Safety
* Crane Co.
* Jenkins Bros.
Lunkenheimer Co.

Valves, Steel (Superheated Steam)
* Crane Co.
* Foster Engineering Co.
* Golden-Anderson Valve Specialty Co.
* Jenkins Bros.
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
Nelson Valve Co.
Schutte & Koerting Co.
Walworth Mfg. Co.

Valves, Stop and Check
(See Valves, Non-Return)

Valves, Throttle
* Crane Co.
* Jenkins Bros.
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
Nelson Valve Co.
Schutte & Koerting Co.

Ventilating and Heating Apparatus
(See Heating and Ventilating Apparatus)

Voltmeters
(See Electrical Instruments)

Wash Bowls
Manufacturing Equipment & Engrg. Co.

Washers, Rubber
* Goodrich Co., B. F.

Washers, Leather
Schieren Co., Chas. A.

Water Cinder Mills
(See Mills, Cinder, Water)

Water Circulators, Filters, Gages, Heaters, Meters, Strainers, etc.
(See Circulators, Filters, Gages, Heaters, Meters, Strainers, etc., Water)

Water Columns
Ashton Valve Co.
Lunkenheimer Co.
Walworth Mfg. Co.

Water Columns, Railway
* Golden-Anderson Valve Specialty Co.

Water Purifying Plants
Electric Water Sterilizer Co.
* Scaife & Sons Co., Wm. B.

Water Softeners and Purifiers
* Scaife & Sons Co., Wm. B.

Water Tube Boilers
(See Boilers, Water Tube)

Water Wheels, Turbine
Holyoke Machine Co.
* Morris Co., I. P.

Waterproofing Materials
Johns-Manville Co., H. W.
* Texas Co.

Wattmeters
(See Electrical Instruments)

Wheels, Polishing, Paper
Rockwood Mfg. Co.

Whistles, Steam
Ashton Valve Co.
Brown Co., A. & F.
* Crane Co.
Lunkenheimer Co.
Walworth Mfg. Co.

Winches
* Lidgerwood Mfg. Co.
Shaw Electric Crane Co.

Wire, Brass and Copper
* Roebling's Sons Co., John A.

Wire, Flat
* Roebling's Sons Co., John A.

Wire, Iron and Steel
* Roebling's Sons Co., John A.

Wire and Cables, Electrical
* General Electric Co.
* Roebling's Sons Co., John A.

Wire Cloth
* Caldwell & Son Co., H. W.
* Roebling's Sons Co., John A.

Wire Rope
(See Rope, Wire)

Wire Rope Fastenings
* Lidgerwood Mfg. Co.
* Roebling's Sons Co., John A.

Wire Specialties
* Roebling's Sons Co., John A.

Wiring Devices
* General Electric Co.

Work Benches
(See Benches, Work)

Wrenches
* Roebling's Sons Co., John A.
Walworth Mfg. Co.

Wrenches, Tap
Wells Bros. Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1915 Volume*


DUXBAK
LEATHER BELTING
DUXBAK
BELTING
TRADE MARK
Duxbak Spells
Higher Efficiency
for every mill, factory or mine that uses it. It simplifies power transmission problems—no lost power or shut downs—it delivers all the power your plant produces and reduces operating expenses. The special process Duxbak belting is subjected to makes it proof against water, steam and acid fumes. Try it on your hardest drives.
Awarded the Gold Medal of Honor at the San Francisco Exposition
Have you heard of the Lenix Drive? Send for pamphlet describing this Cost-saving system
Chas. A. Schieren Company
ESTABLISHED 1868
Tanners, Belt Manufacturers
25 Ferry St., New York
Chicago . . 128 W. Kinzie St.
Philadelphia . 226 North 3rd St.
Denver . . 1752 Arapahoe St.
Boston . 641-643 Atlantic Ave.
Pittsburgh . 337 Second Ave.
Seattle . . 305 First Ave., South
Petersburg, Va., . 122 Shore St.
New Orleans, La., 402 Canal St.
The Texas Chas. A. Schieren Co., Inc.
106 S. Market St.. . . Dallas, Texas
Oak Leather Tanneries
Bristol, Tenn.

ALPHABETICAL LIST OF ADVERTISERS

See Pages 40-52 for Classified List of Mechanical Equipment

Catalogue data of firms marked appear in the A.S.M.E. Condensed Catalogues of Mechanical Equipment, 1915 Volume*

THE JOURNAL OF

THE AMERICAN SOCIETY
OF
MECHANICAL ENGINEERS

29 West 39th Street, New York